Development of a Probability-Based Monitoring and Assessment Strategy for Select Large Rivers within US EPA Region 5

Appendices

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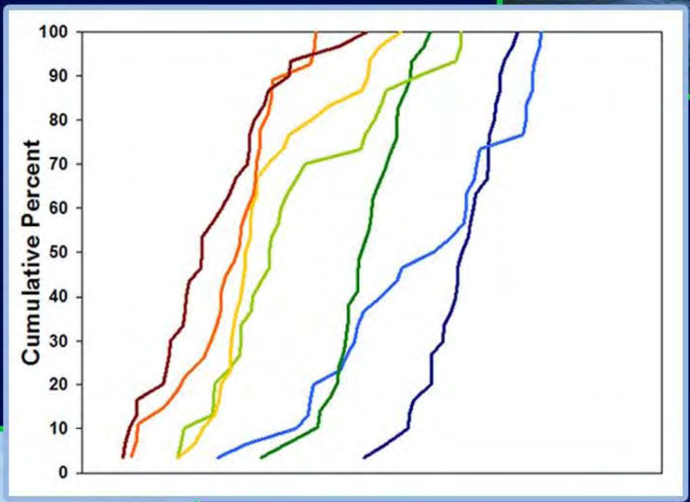

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APPENDIX 1. SITE INFORMATION AND MAPS

1.1. SITE INFORMATION

Site information listed in Table 1 details the exact geographical locations of the start of each 500m electrofishing zone, temporal designation (day or night) and sampling organization. Each site has its own unique event code which is comprised of the river abbreviation, river mile, sample bank and sample date (mm/dd/yyyy).

Table 1. Site location, date and Collector information.

EVENT CODE	RMI	SITE ID	BANK	RIVER	LAT_DD	LON_DD	D/N	COLLECTOR
ILL014.4LDB10102006	14.4	103LDB	LDB	ILLINOIS	39.06147	90.57998	NIGHT	ORSANCO
ILL027.0LDB10192006	27.0	111LDB	LDB	ILLINOIS	39.43409	90.61270	NIGHT	ORSANCO
ILL030.1RDB10182006	30.1	96RDB	RDB	ILLINOIS	39.27153	90.60836	NIGHT	ORSANCO
ILL039.5LDB10192006	39.5	99LDB	LDB	ILLINOIS	39.40720	90.61413	NIGHT	ORSANCO
ILL041.3LDB10182006	41.3	101LDB	LDB	ILLINOIS	39.23564	90.59595	NIGHT	ORSANCO
ILL059.6LDB10092006	59.6	117LDB	LDB	ILLINOIS	39.68260	90.63715	NIGHT	ORSANCO
ILL064.7RDB10042006	64.7	114RDB	RDB	ILLINOIS	39.75195	90.61659	NIGHT	ORSANCO
ILL066.0RDB10042006	66.0	109RDB	RDB	ILLINOIS	39.76530	90.60835	NIGHT	ORSANCO
ILL069.9RDB10042006	69.9	110RDB	RDB	ILLINOIS	39.81632	90.57977	NIGHT	ORSANCO
ILL085.2LDB10052006	85.2	108LDB	LDB	ILLINOIS	39.99893	90.49427	NIGHT	ORSANCO
ILL094.5LDB10032006	94.5	95LDB	LDB	ILLINOIS	40.08986	90.39293	NIGHT	ORSANCO
ILL098.3LDB10032006	98.3	97LDB	LDB	ILLINOIS	40.12515	90.34840	NIGHT	ORSANCO
ILL131.2RDB09282006	131.2	116RDB	RDB	ILLINOIS	40.41114	89.96876	NIGHT	ORSANCO
ILL154.8LDB09272006	154.8	91LDB	LDB	ILLINOIS	40.59934	89.65825	NIGHT	ORSANCO
ILL159.8RDB09212006	159.8	104RDB	RDB	ILLINOIS	40.65389	89.61459	NIGHT	ORSANCO
ILL177.3RDB09272006	177.3	121RDB	RDB	ILLINOIS	40.88134	89.49945	NIGHT	ORSANCO
ILL190.0LDB09202006	190.0	120LDB	LDB	ILLINOIS	41.03607	89.41420	NIGHT	ORSANCO
ILL194.7LDB09202006	194.7	94LDB	LDB	ILLINOIS	41.09215	89.36606	NIGHT	ORSANCO
ILL202.3LDB09262006	202.3	112LDB	LDB	ILLINOIS	41.19342	89.32948	NIGHT	ORSANCO
ILL214.2RDB09252006	214.2	115RDB	RDB	ILLINOIS	41.31635	89.27979	NIGHT	ORSANCO
ILL220.4LDB09252006	220.4	122LDB	LDB	ILLINOIS	41.30844	89.16544	NIGHT	ORSANCO
ILL228.8LDB09112006	228.8	118LDB	LDB	ILLINOIS	41.32332	89.02326	NIGHT	ORSANCO
ILL251.1LDB08162006	251.1	92LDB	LDB	ILLINOIS	41.30656	88.63554	NIGHT	ORSANCO
ILL254.0LDB08162006	254.0	106LDB	LDB	ILLINOIS	41.30630	88.58366	NIGHT	ORSANCO
ILL269.5RDB08172006	269.5	119RDB	RDB	ILLINOIS	41.38842	88.31938	NIGHT	ORSANCO
ILL273.3RDB08152006	273.3	105RDB	RDB	ILLINOIS	41.39024	88.25008	NIGHT	ORSANCO
ILL275.0RDB08152006	275.0	100RDB	RDB	ILLINOIS	41.39197	88.23251	NIGHT	ORSANCO
ILL290.3LDB07212006	290.3	98LDB	LDB	ILLINOIS	41.55664	88.07866	DAY	MBI
ILL297.1LDB07282006	297.1	107LDB	LDB	ILLINOIS	41.65501	88.06129	DAY	MBI
ILL298.3LDB07282006	298.3	93LDB	LDB	ILLINOIS	41.66752	88.04425	DAY	MBI
MINN021.2LDB07112006	21.1	280 LDB	LDB	MINNESOTA	44.81338	93.43854	DAY	ORSANCO
MINN026.0RDB07112006	26.0	283 RDB	RDB	MINNESOTA	44.80472	93.50988	DAY	ORSANCO
MINN042.8RDB07122006	42.8	312 RDB	RDB	MINNESOTA	44.68958	93.65592	DAY	ORSANCO
MINN049.0LDB07112006	49.1	303 RDB	RDB	MINNESOTA	44.65424	93.72865	DAY	ORSANCO
MINN096.6LDB07122006	96.7	291 LDB	LDB	MINNESOTA	44.33978	93.93655	DAY	ORSANCO
MINN106.2RDB07122006	106.2	305 RDB	RDB	MINNESOTA	44.24602	94.01626	DAY	ORSANCO

MINN109.1LDB07122006	109.1	271 LDB	LDB	MINNESOTA	44.22927	94.01504	DAY	ORSANCO
MINN124.2LDB07132006	124.3	295 RDB	RDB	MINNESOTA	44.19247	94.15442	DAY	ORSANCO
MINN150.2LDB07132006	150.0	290 LDB	LDB	MINNESOTA	44.31114	94.44557	DAY	ORSANCO
MINN153.0RDB07132006	153.0	277 RDB	RDB	MINNESOTA	44.33350	94.46477	DAY	ORSANCO
MINN154.7LDB07132006	154.7	302 LDB	LDB	MINNESOTA	44.35058	94.49037	DAY	ORSANCO
MINN160.1RDB07132006	160.0	304 RDB	RDB	MINNESOTA	44.37123	94.55845	DAY	ORSANCO
MINN164.7LDB07142006	164.7	272 LDB	LDB	MINNESOTA	44.38418	94.62635	DAY	ORSANCO
MINN166.6RDB07142006	166.6	293 RDB	RDB	MINNESOTA	44.39621	94.63941	DAY	ORSANCO
MINN173.2RDB07142006	173.1	288 LDB	LDB	MINNESOTA	44.41029	94.68438	DAY	ORSANCO
MINN178.4LDB07142006	178.3	289 RDB	RDB	MINNESOTA	44.44059	94.73116	DAY	ORSANCO
MINN181.9RDB07162006	181.9	313 RDB	RDB	MINNESOTA	44.45380	94.78591	DAY	ORSANCO
MINN212.1RDB07142006	212.1	294 RDB	RDB	MINNESOTA	44.57491	95.09849	DAY	ORSANCO
MINN214.9LDB07152006	214.9	298 LDB	LDB	MINNESOTA	44.58456	95.10173	DAY	ORSANCO
MINN229.9LDB07152006	229.9	286 LDB	LDB	MINNESOTA	44.66165	95.24026	DAY	ORSANCO
MINN239.7LDB07152006	239.7	292 LDB	LDB	MINNESOTA	44.74334	95.44581	DAY	ORSANCO
MINN244.8LDB07162006	244.8	274 LDB	LDB	MINNESOTA	44.76657	95.51510	DAY	ORSANCO
MINN256.0LDB07162006	256.0	276 LDB	LDB	MINNESOTA	44.80471	95.54422	DAY	ORSANCO
MINN266.6RDB07172006	266.6	285 RDB	RDB	MINNESOTA	44.90381	95.69575	DAY	ORSANCO
MINN270.0RDB07162006	270.0	309 RDB	RDB	MINNESOTA	44.93265	95.73267	DAY	ORSANCO
MINN275.3LDB07172006	275.3	287 LDB	LDB	MINNESOTA	44.95769	95.80870	DAY	ORSANCO
MINN300.1RDB07172006	300.1	297 LDB	LDB	MINNESOTA	45.16104	96.06540	DAY	ORSANCO
MUSK027.5RDB08242006	27.5	455RDB	RDB	MUSKINGUM	39.58148	81.67131	NIGHT	ORSANCO
MUSK037.2RDB08242006	37.2	451RDB	RDB	MUSKINGUM	39.52160	81.75534	NIGHT	ORSANCO
MUSK055.9RDB08242006	55.9	471RDB	RDB	MUSKINGUM	39.72105	81.88680	NIGHT	ORSANCO
MUSK060.7RDB08022006	60.7	460RDB	RDB	MUSKINGUM	39.76972	81.89846	NIGHT	ORSANCO
MUSK062.2RDB08022006	62.2	472RDB	RDB	MUSKINGUM	39.78951	81.90817	NIGHT	ORSANCO
MUSK066.6LDB08232006	66.6	473LDB	LDB	MUSKINGUM	39.84694	81.89987	NIGHT	ORSANCO
MUSK077.7RDB08012006	77.7	457RDB	RDB	MUSKINGUM	39.94918	82.00459	NIGHT	ORSANCO
MUSK078.7RDB08012006	78.7	464RDB	RDB	MUSKINGUM	39.95559	81.99770	NIGHT	ORSANCO
MUSK081.4LDB08012006	81.4	456LDB	LDB	MUSKINGUM	39.99058	81.97655	NIGHT	ORSANCO
MUSK086.6LDB08142006	86.6	459LDB	LDB	MUSKINGUM	40.05053	81.97177	DAY	MBI
MUSK093.1LDB08142006	93.1	476LDB	LDB	MUSKINGUM	40.12105	81.99933	DAY	MBI
MUSK100.0LDB08162006	100	479LDB	LDB	MUSKINGUM	40.14853	81.92532	DAY	MBI
MUSK107.2LDB08162006	107.2	470LDB	LDB	MUSKINGUM	40.21360	81.87825	DAY	MBI
MUSK109.3RDB08162006	109.3	466RDB	RDB	MUSKINGUM	40.23210	81.86961	DAY	MBI
TUSC113.2LDB08152006	113.2	468LDB	LDB	MUSKINGUM	40.28294	81.86308	DAY	MBI
TUSC118.3LDB08152006	118.3	453LDB	LDB	MUSKINGUM	40.28270	81.80482	DAY	MBI
TUSC119.8RDB08152006	119.8	463RDB	RDB	MUSKINGUM	40.28954	81.79318	DAY	MBI
TUSC123.9RDB08152006	123.9	477RDB	RDB	MUSKINGUM	40.28955	81.73901	DAY	MBI
TUSC129.1RDB08132006	129.1	469RDB	RDB	MUSKINGUM	40.27968	81.66486	DAY	MBI
TUSC132.2RDB08132006	132.2	462RDB	RDB	MUSKINGUM	40.26760	81.63151	DAY	MBI
TUSC132.8LDB08132006	132.8	475LDB	LDB	MUSKINGUM	40.26115	81.62481	DAY	MBI
TUSC134.4RDB08132006	134.4	465RDB	RDB	MUSKINGUM	40.26280	81.59976	DAY	MBI
TUSC141.7LDB08122006	141.7	461LDB	LDB	MUSKINGUM	40.30623	81.53036	DAY	MBI
TUSC156.9LDB08112006	156.9	452LDB	LDB	MUSKINGUM	40.42377	81.37469	DAY	MBI
TUSC158.8LDB08112006	158.8	480LDB	LDB	MUSKINGUM	40.42495	81.38871	DAY	MBI
TUSC160.4RDB08112006	160.4	454RDB	RDB	MUSKINGUM	40.44115	81.40578	DAY	MBI
TUSC163.0LDB08112006	163	467LDB	LDB	MUSKINGUM	40.46513	81.43623	DAY	MBI

TUSC173.3LDB08122006	173.3	474LDB	LDB	MUSKINGUM	40.55305	81.41890	DAY	MBI
TUSC176.5LDB08102006	176.5	478LDB	LDB	MUSKINGUM	40.58491	81.40206	DAY	MBI
TUSC177.4LDB08102006	177.4	458LDB	LDB	MUSKINGUM	40.59429	81.40491	DAY	MBI
SCIO001.2LDB072605	1.2	758LDB	LDB	SCIOTO	38.74285	83.00672	DAY	ORSANCO
SCIO002.2RDB072605	2.2	728LDB	LDB	SCIOTO	38.75652	83.01295	DAY	ORSANCO
SCIO030.9LDB072705	30.9	749LDB	LDB	SCIOTO	39.05753	83.0464	DAY	ORSANCO
SCIO033.2RDB072705	33.2	748RDB	RDB	SCIOTO	39.07838	83.02472	DAY	ORSANCO
SCIO041.4LDB101105	41.4	733LDB	LDB	SCIOTO	39.12043	82.94227	DAY	ORSANCO
SCIO042.5RDB101105	42.5	722RDB	RDB	SCIOTO	39.12728	82.92525	DAY	ORSANCO
SCIO048.3LDB101105	48.3	725LDB	LDB	SCIOTO	39.1558	82.8583	DAY	ORSANCO
SCIO048.6LDB101105	48.6	757LDB	LDB	SCIOTO	39.15865	82.8539	DAY	ORSANCO
SCIO055.8LDB101105	55.8	735LDB	LDB	SCIOTO	39.2062	82.85916	DAY	ORSANCO
SCIO056.9LDB101105	56.9	737LDB	LDB	SCIOTO	39.21864	82.87227	DAY	ORSANCO
SCIO065.5RDB101005	65.5	754RDB	RDB	SCIOTO	39.31818	82.9284	DAY	ORSANCO
SCIO067.4LDB101205	67.4	736LDB	LDB	SCIOTO	39.32873	82.94247	DAY	ORSANCO
SCIO075.4RDB101805	75.4	730RDB	RDB	SCIOTO	39.38928	83.00253	DAY	ORSANCO
SCIO076.6RDB101805	76.6	738RDB	RDB	SCIOTO	39.39448	82.9807	DAY	ORSANCO
SCIO078.3RDB101805	78.3	726RDB	RDB	SCIOTO	39.41375	82.99382	DAY	ORSANCO
SCIO097.1LDB081605	97.1	727LDB	LDB	SCIOTO	39.58806	82.97015	DAY	ORSANCO
SCIO099.7LDB081705	99.7	747LDB	LDB	SCIOTO	39.60993	82.96087	DAY	ORSANCO
SCIO102.0RDB101105	102	741RDB	RDB	SCIOTO	39.633	82.9626	DAY	MBI
SCIO105.2RDB101105	105.2	742RDB	RDB	SCIOTO	39.6738	82.9903	DAY	MBI
SCIO113.8LDB101305	113.8	746LDB	LDB	SCIOTO	39.7622	82.9964	DAY	MBI
SCIO118.9RDB081705	118.9	732RDB	RDB	SCIOTO	39.83071	83.01243	DAY	ORSANCO
SCIO123.5RDB101805	123.5	753RDB	RDB	SCIOTO	39.8799	83.0179	DAY	MBI
SCIO126.4RDB101805	126.4	731RDB	RDB	SCIOTO	39.9017	83.0186	DAY	MBI
SCIO129.1RDB101605	129.1	744RDB	RDB	SCIOTO	39.9372	82.9995	DAY	MBI
SCIO131.8RDB101405	131.8	755RDB	RDB	SCIOTO	39.9646	83.0134	DAY	MBI
SCIO133.0LDB101405	133	739LDB	LDB	SCIOTO	39.9672	83.0341	DAY	MBI
SCIO133.4LDB101405	133.4	743LDB	LDB	SCIOTO	39.966359	83.0489563	DAY	MBI
SCIO138.8RDB072105	138.8	752RDB	RDB	SCIOTO	40.03205	83.09571	NIGHT	ORSANCO
SCIO141.0LDB072005	141	745RDB	RDB	SCIOTO	40.06339	83.10421	NIGHT	ORSANCO
SCIO149.4RDB072105	149.4	724RDB	RDB	SCIOTO	40.18147	83.13191	NIGHT	ORSANCO
STC004.6RDB072704	4.6	648RDB	RDB	ST.CROIX	44.8091	92.78571	NIGHT	ORSANCO
STC007.2LDB072704	7.2	644LDB	LDB	ST.CROIX	44.84058	92.76245	NIGHT	ORSANCO
STC017.6RDB071904	17.6	636RDB	RDB	ST.CROIX	44.98686	92.77542	NIGHT	ORSANCO
STC023.4LDB072104	23.4	645LDB	LDB	ST.CROIX	45.06216	92.79946	NIGHT	ORSANCO
STC025.6LDB072104	25.6	640LDB	LDB	ST.CROIX	45.0905	92.77175	NIGHT	ORSANCO
STC027.6RDB072204	27.6	662RDB	RDB	ST.CROIX	45.10567	92.75248	NIGHT	ORSANCO
STC028.1RDB072304	28.1	655RDB	RDB	ST.CROIX	45.10867	92.74514	NIGHT	ORSANCO
STC030.1RDB081004	30	643LDB	LDB	ST.CROIX	45.13470	92.74929	DAY	ORSANCO
STC036.2RDB072304	36.2	661RDB	RDB	ST.CROIX	45.21353	92.75534	NIGHT	ORSANCO
STC038.3RDB072304	38.3	658RDB	RDB	ST.CROIX	45.24301	92.75944	NIGHT	ORSANCO
STC044.4LDB072604	44.4	642LDB	LDB	ST.CROIX	45.31427	92.71869	NIGHT	ORSANCO
STC046.3LDB072504	46.3	653LDB	LDB	ST.CROIX	45.33743	92.69816	NIGHT	ORSANCO
STC047.9LDB090404	47.9	647LDB	LDB	ST.CROIX	45.35919	92.70065	DAY	ORSANCO
STC056.5RDB090504	56.5	673RDB	RDB	ST.CROIX	45.45854	92.66441	DAY	ORSANCO
STC062.4RDB081104	62.4	660RDB	RDB	ST.CROIX	45.52676	92.72870	DAY	ORSANCO

STC064.8LDB081104	64.8	651LDB	LDB	ST.CROIX	45.55375	92.74733	DAY	ORSANCO
STC079.2LDB081104	79.2	649LDB	LDB	ST.CROIX	45.67359	92.87700	DAY	ORSANCO
STC081.2LDB081204	81.2	668LDB	LDB	ST.CROIX	45.70652	92.86895	DAY	ORSANCO
STC082.8LDB081204	82.8	638LDB	LDB	ST.CROIX	45.72181	92.85904	DAY	ORSANCO
STC091.8LDB081204	91.8	641LDB	LDB	ST.CROIX	45.81459	92.75927	DAY	ORSANCO
STC094.6RDB083004	94.6	635RDB	RDB	ST.CROIX	45.83030	92.74750	DAY	ORSANCO
STC097.9LDB090304	98.1	633LDB	LDB	ST.CROIX	45.88693	92.71668	DAY	ORSANCO
STC098.6RDB090304	98.6	666RDB	RDB	ST.CROIX	45.89353	92.70961	DAY	ORSANCO
STC102.2LDB090304	102.2	659LDB	LDB	ST.CROIX	45.92437	92.65500	DAY	ORSANCO
STC104.7LDB090304	104.6	665LDB	LDB	ST.CROIX	45.93515	92.62020	DAY	ORSANCO
STC107.9RDB090204	107.9	654RDB	RDB	ST.CROIX	45.95197	92.55964	DAY	ORSANCO
STC114.2RDB090204	114.2	657RDB	RDB	ST.CROIX	45.97524	92.46602	DAY	ORSANCO
STC115.1RDB090204	115.1	669RDB	RDB	ST.CROIX	45.98524	92.46495	DAY	ORSANCO
STC116.6LDB090204	116.5	672LDB	LDB	ST.CROIX	46.00193	92.44973	DAY	ORSANCO
STC128.2RDB083104	128.2	667RDB	RDB	ST.CROIX	46.07464	92.29406	DAY	ORSANCO
WAB007.0LDB101404	7	818LDB	LDB	WABASH	37.82294	88.06561	NIGHT	ORSANCO
WAB025.9RDB101304	25.9	835RDB	RDB	WABASH	37.93864	88.03408	NIGHT	ORSANCO
WAB029.5RDB101504	29.5	848RDB	RDB	WABASH	37.97545	88.01359	NIGHT	ORSANCO
WAB046.3LDB101504	46.3	843LDB	LDB	WABASH	38.13455	87.94010	NIGHT	ORSANCO
WAB081.9LDB101304	81.9	841LDB	LDB	WABASH	38.36773	87.78160	NIGHT	ORSANCO
WAB082.4RDB101304	82.4	816RDB	RDB	WABASH	38.37442	87.77850	NIGHT	ORSANCO
WAB108.2RDB101004	108.2	833RDB	RDB	WABASH	38.59419	87.62112	NIGHT	ORSANCO
WAB118.0LDB101104	118	827LDB	LDB	WABASH	38.68359	87.53050	NIGHT	ORSANCO
WAB130.3LDB102104	130.3	852LDB	LDB	WABASH	38.81568	87.52411	NIGHT	ORSANCO
WAB133.5LDB092304	133.5	844LDB	LDB	WABASH	38.85379	87.53537	NIGHT	ORSANCO
WAB159.1LDB102104	159.1	812LDB	LDB	WABASH	39.08220	87.61381	NIGHT	ORSANCO
WAB166.3LDB102104	166.3	826LDB	LDB	WABASH	39.14089	87.65435	NIGHT	ORSANCO
WAB179.0LDB092104	179	834LDB	LDB	WABASH	39.27965	87.60891	NIGHT	ORSANCO
WAB186.5LDB102104	186.5	850LDB	LDB	WABASH	39.32182	87.59574	NIGHT	ORSANCO
WAB201.2LDB102004	201.2	813LDB	LDB	WABASH	39.42615	87.43701	NIGHT	ORSANCO
WAB208.0LDB102004	208	832LDB	LDB	WABASH	39.48895	87.43157	NIGHT	ORSANCO
WAB231.0RDB101804	231	831RDB	RDB	WABASH	39.77178	87.37813	NIGHT	ORSANCO
WAB231.6LDB101804	231.6	814LDB	LDB	WABASH	39.78033	87.37307	NIGHT	ORSANCO
WAB247.2LDB101904	247.2	845LDB	LDB	WABASH	39.93032	87.43167	NIGHT	ORSANCO
WAB262.3LDB101804	262.3	825LDB	LDB	WABASH	40.11501	87.40655	NIGHT	ORSANCO
WAB265.3RDB101804	265.3	851RDB	RDB	WABASH	40.14884	87.42505	NIGHT	ORSANCO
WAB290.4RDB100504	290.4	828RDB	RDB	WABASH	40.35654	87.10832	DAY	ORSANCO
WAB295.3RDB100504	295.3	824RDB	RDB	WABASH	40.39647	86.94870	DAY	ORSANCO
WAB301.5RDB100504	301.5	829RDB	RDB	WABASH	40.40932	87.05446	DAY	ORSANCO
WAB305.2RDB093004	305.2	838RDB	RDB	WABASH	40.42124	86.89701	DAY	ORSANCO
WAB322.1RDB093004	322.1	839RDB	RDB	WABASH	40.56786	86.69580	DAY	ORSANCO
WAB352.4LDB092904	352.4	830LDB	LDB	WABASH	40.75310	86.28456	DAY	ORSANCO
WAB369.6LDB100604	369.6	836LDB	LDB	WABASH	40.75803	86.00840	DAY	ORSANCO
WAB373.4LDB092804	373.4	847LDB	LDB	WABASH	40.77154	85.94322	DAY	ORSANCO
WAB380.0RDB092904	380	823RDB	RDB	WABASH	40.79062	85.82803	DAY	ORSANCO
WISC003.9RDB071205	3.9	922LDB	LDB	WISCONSIN	43.00043	91.06268	DAY	ORSANCO
WISC006.2LDB071205	6.2	919LDB	LDB	WISCONSIN	43.0066	91.02393	DAY	ORSANCO
WISC022.0RDB071205	22	920RDB	RDB	WISCONSIN	43.11335	90.78475	DAY	ORSANCO

WISC041.2LDB090905	41.2	928LDB	LDB	WISCONSIN	43.201583	90.46485	DAY	MBI
WISC083.0RDB071305	83	912RDB	RDB	WISCONSIN	43.24305	89.75458	DAY	ORSANCO
WISC084.1RDB071305	84.1	931RDB	RDB	WISCONSIN	43.25215	89.74872	DAY	ORSANCO
WISC094.0RDB083005	94	908RDB	RDB	WISCONSIN	43.36978	89.63381	NIGHT	ORSANCO
WISC094.4RDB083005	94.4	910RDB	RDB	WISCONSIN	43.36901	89.64162	NIGHT	ORSANCO
WISC105.3LDB071105	105.3	909LDB	LDB	WISCONSIN	43.45688	89.47409	DAY	ORSANCO
WISC112.2RDB071105	112.2	921RDB	RDB	WISCONSIN	43.5318	89.46167	DAY	ORSANCO
WISC127.3RDB071005	127.3	929RDB	RDB	WISCONSIN	43.57442	89.73605	DAY	ORSANCO
WISC147.8LDB071005	147.8	926LDB	LDB	WISCONSIN	43.79351	89.87947	DAY	ORSANCO
WISC164.6RDB090805	164.6	918RDB	RDB	WISCONSIN	43.99921	89.98842	NIGHT	ORSANCO
WISC169.5RDB090105	169.5	915RDB	RDB	WISCONSIN	44.04643	90.01937	NIGHT	ORSANCO
WISC179.7LDB090905	179.7	930RDB	RDB	WISCONSIN	44.16249	89.90308	NIGHT	ORSANCO
WISC188.8LDB070905	188.8	903LDB	LDB	WISCONSIN	44.27822	89.9072	DAY	ORSANCO
WISC195.1RDB090205	195.1	934RDB	RDB	WISCONSIN	44.33489	89.86384	NIGHT	ORSANCO
WISC199.8LDB070905	199.8	913LDB	LDB	WISCONSIN	44.38375	89.83231	DAY	ORSANCO
WISC213.4LDB070905	213.4	935LDB	LDB	WISCONSIN	44.46328	89.60786	DAY	ORSANCO
WISC223.2RDB091005	223.2	916RDB	RDB	WISCONSIN	44.5528	89.64589	NIGHT	ORSANCO
WISC230.9RDB070805	230.9	925RDB	RDB	WISCONSIN	44.64922	89.64288	DAY	ORSANCO
WISC236.2RDB091105	236.2	936RDB	RDB	WISCONSIN	44.71422	89.71197	NIGHT	ORSANCO
WISC242.9LDB091205	242.9	904LDB	LDB	WISCONSIN	44.76818	89.72682	NIGHT	ORSANCO
WISC245.7RDB091405	245.7	933RDB	RDB	WISCONSIN	44.79799	89.70671	NIGHT	ORSANCO
WISC255.7RDB091405	255.7	911RDB	RDB	WISCONSIN	44.90623	89.64374	NIGHT	ORSANCO
WISC260.1RDB070805	260.1	923RDB	RDB	WISCONSIN	44.94947	89.63152	DAY	ORSANCO
WISC286.7LDB091505	286.7	017LDB	LDB	WISCONSIN	45.19219	89.75109	NIGHT	ORSANCO
WISC297.5RDB070805	297.5	924RDB	RDB	WISCONSIN	45.32219	89.78208	DAY	ORSANCO
WISC307.0RDB070705	307	901RDB	RDB	WISCONSIN	45.42474	89.69674	DAY	ORSANCO

1.2. SITE MAPS

1.2.1. St. Croix River (2004)

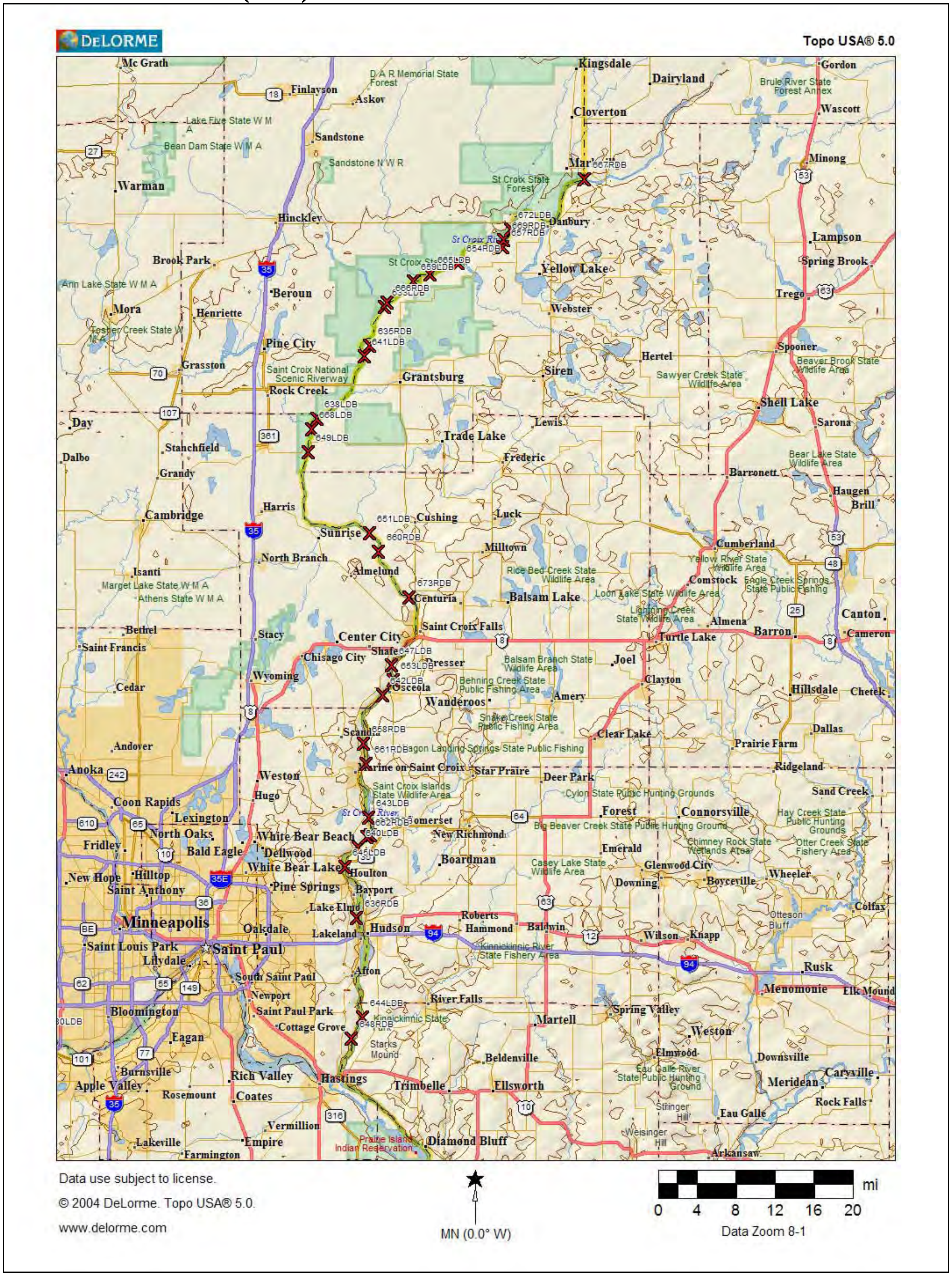


Figure 1. St. Croix River sites; ORSANCO (X); 2004.

1.2.1. St. Croix River (2004)

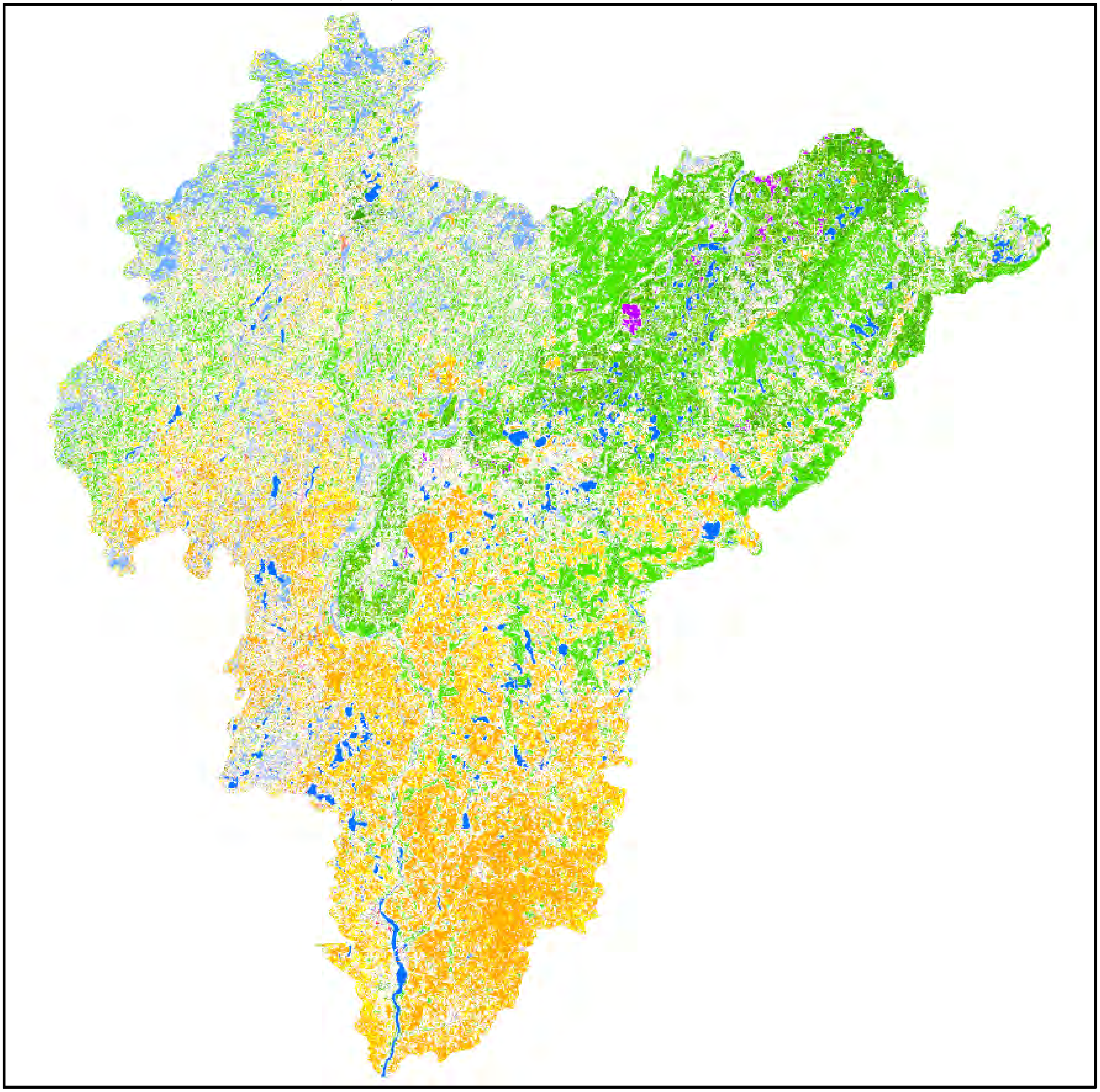


Figure 2. St. Croix River land use map.

1.2.2. Wabash River (2004)

Figure 3. Wabash River sites; ORSANCO (X); 2004.

1.2.2. Wabash River (2004)

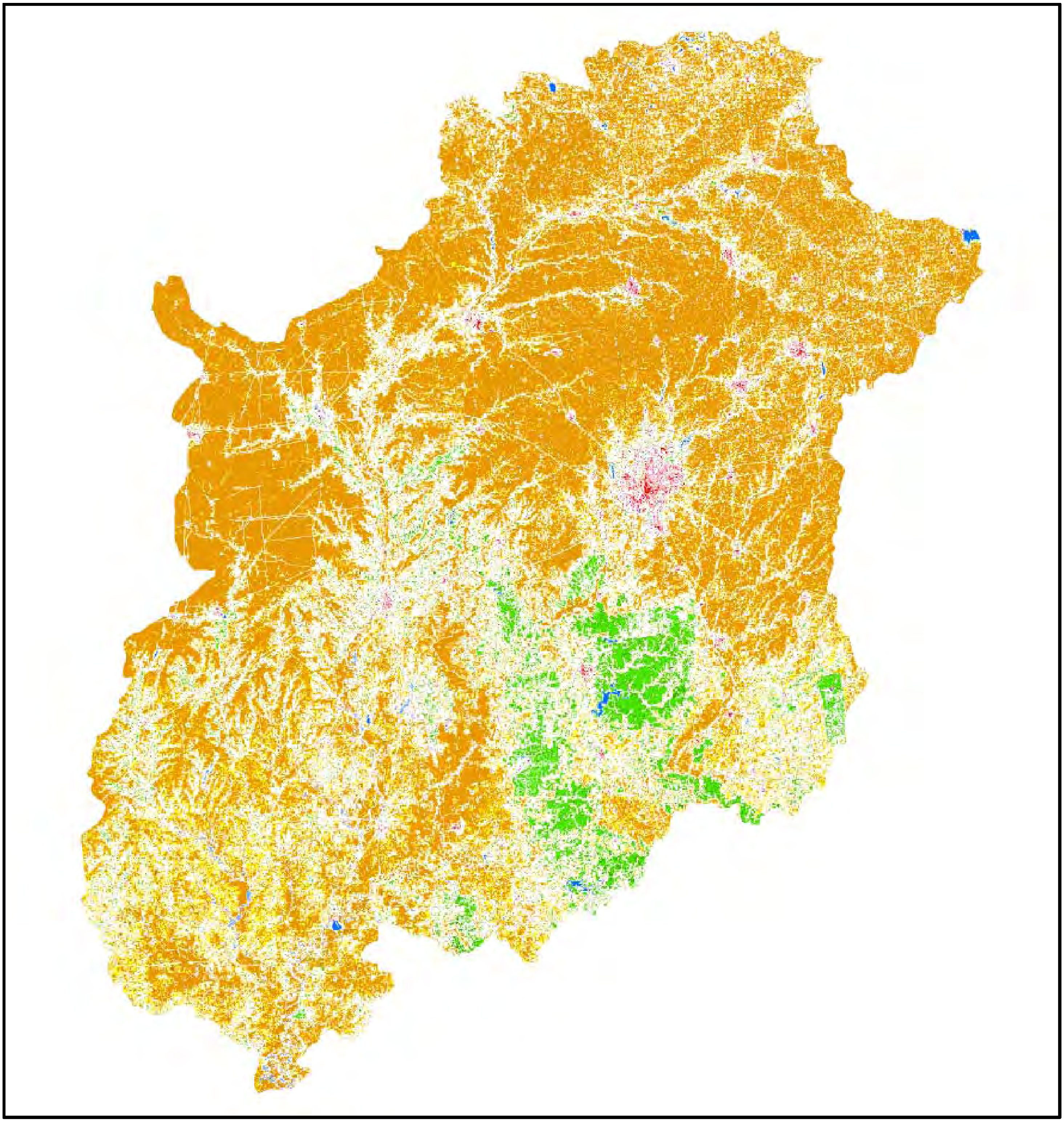


Figure 4. Wabash River land use map.

1.2.3. Wisconsin River (2005)

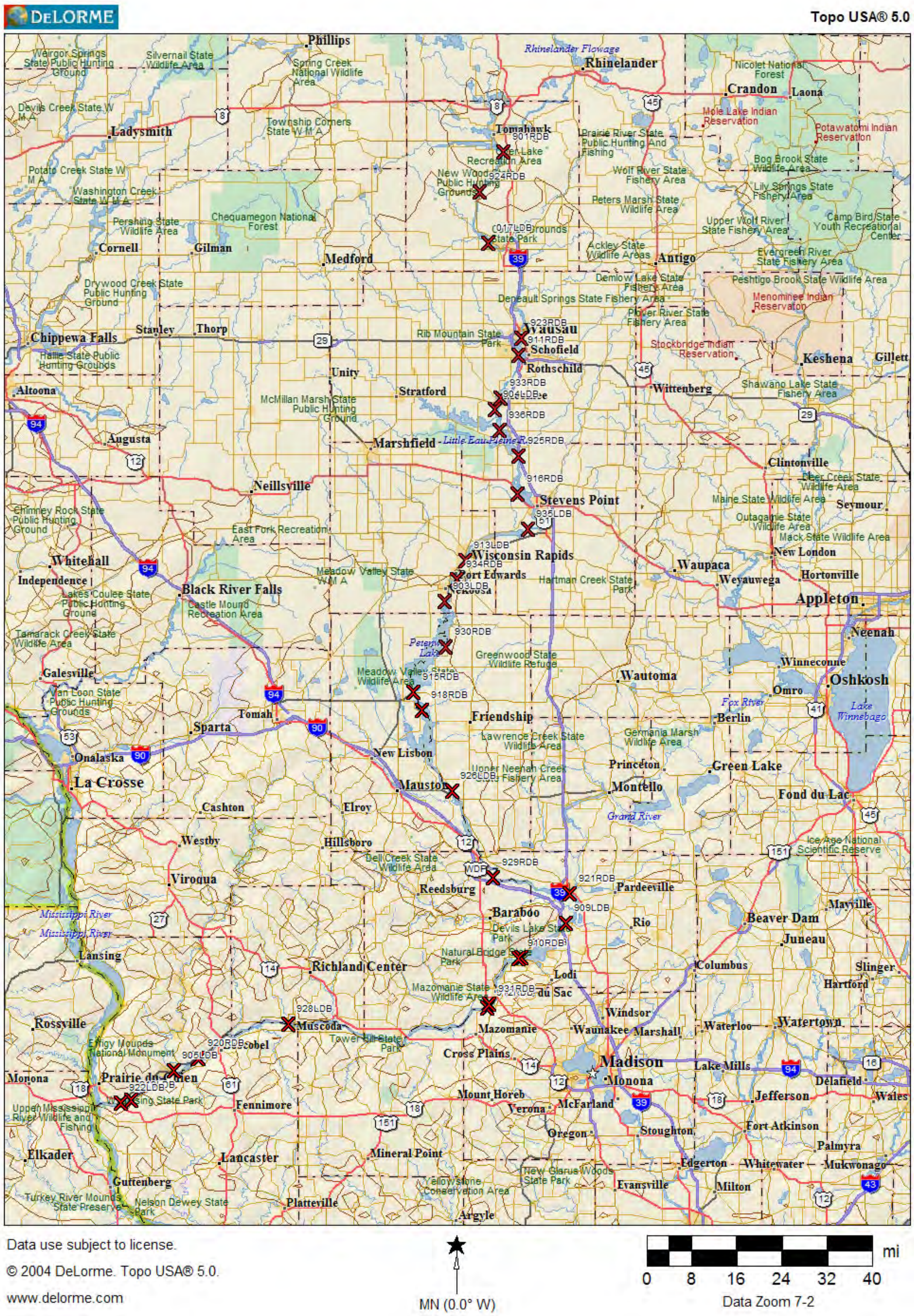


Figure 5. Wisconsin River sites; ORSANCO (X); 2005.

1.2.3. Wisconsin River (2005)

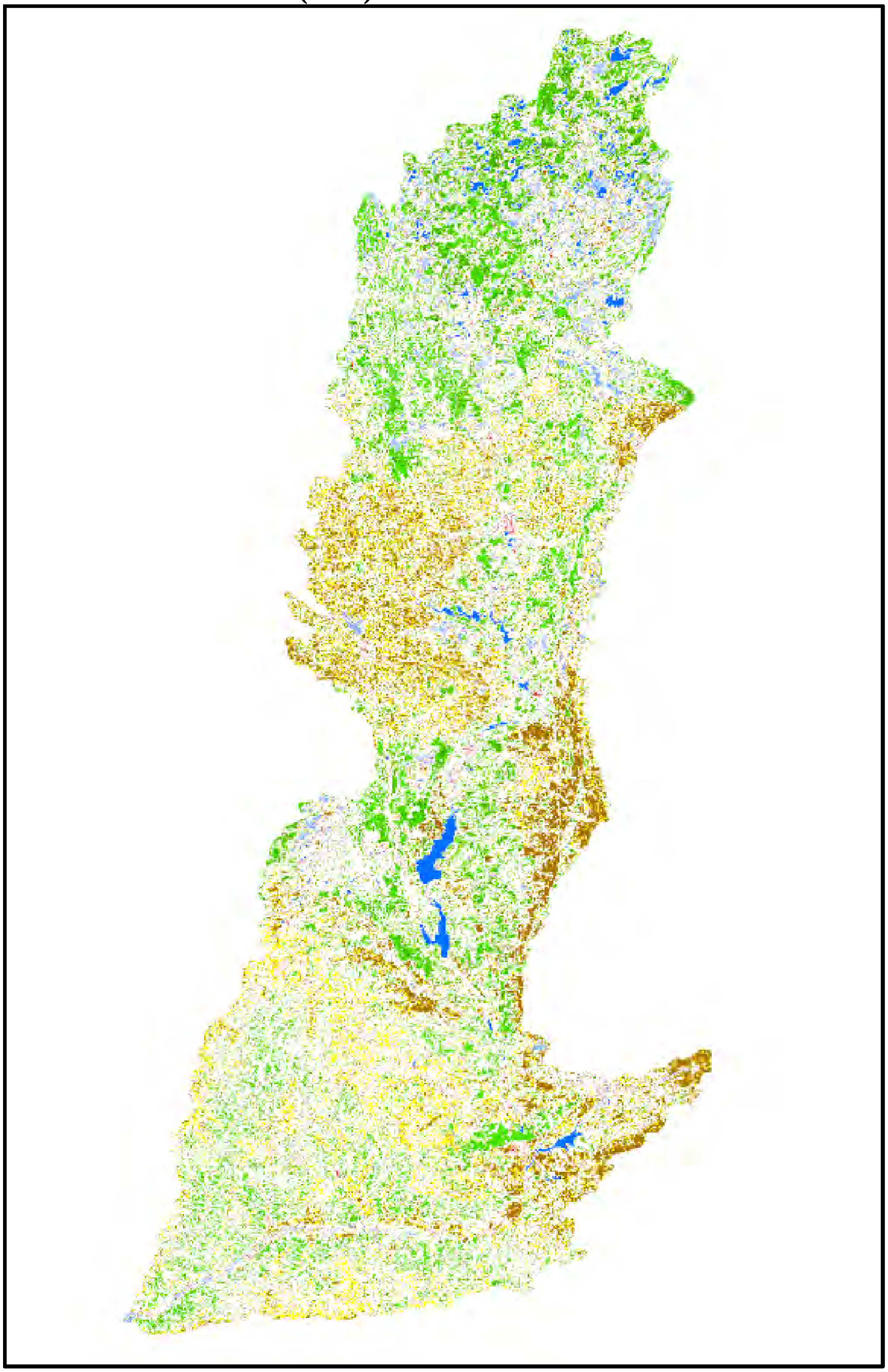


Figure 6. Wisconsin River land use map.

1.2.4. Scioto River (2005)

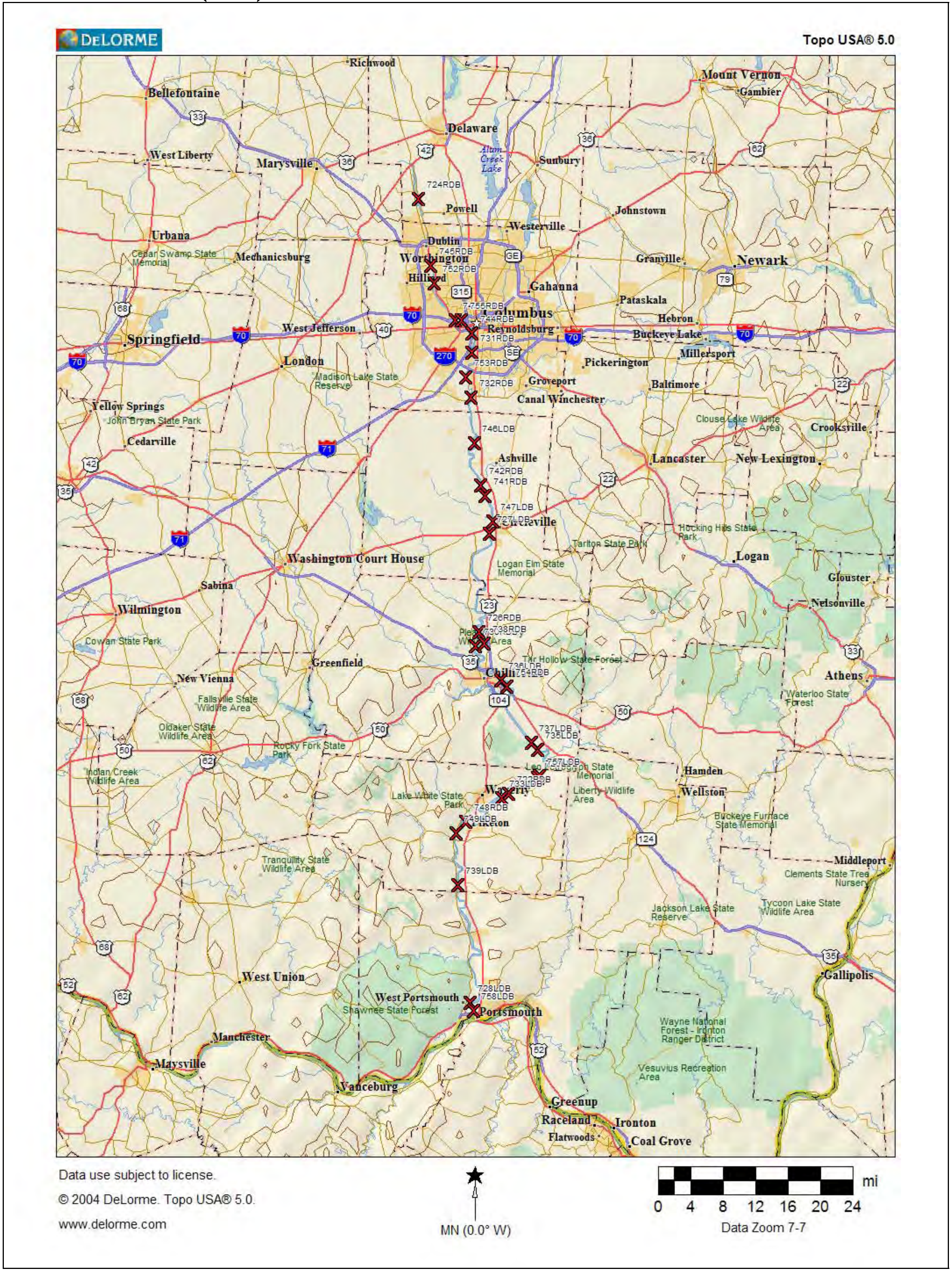
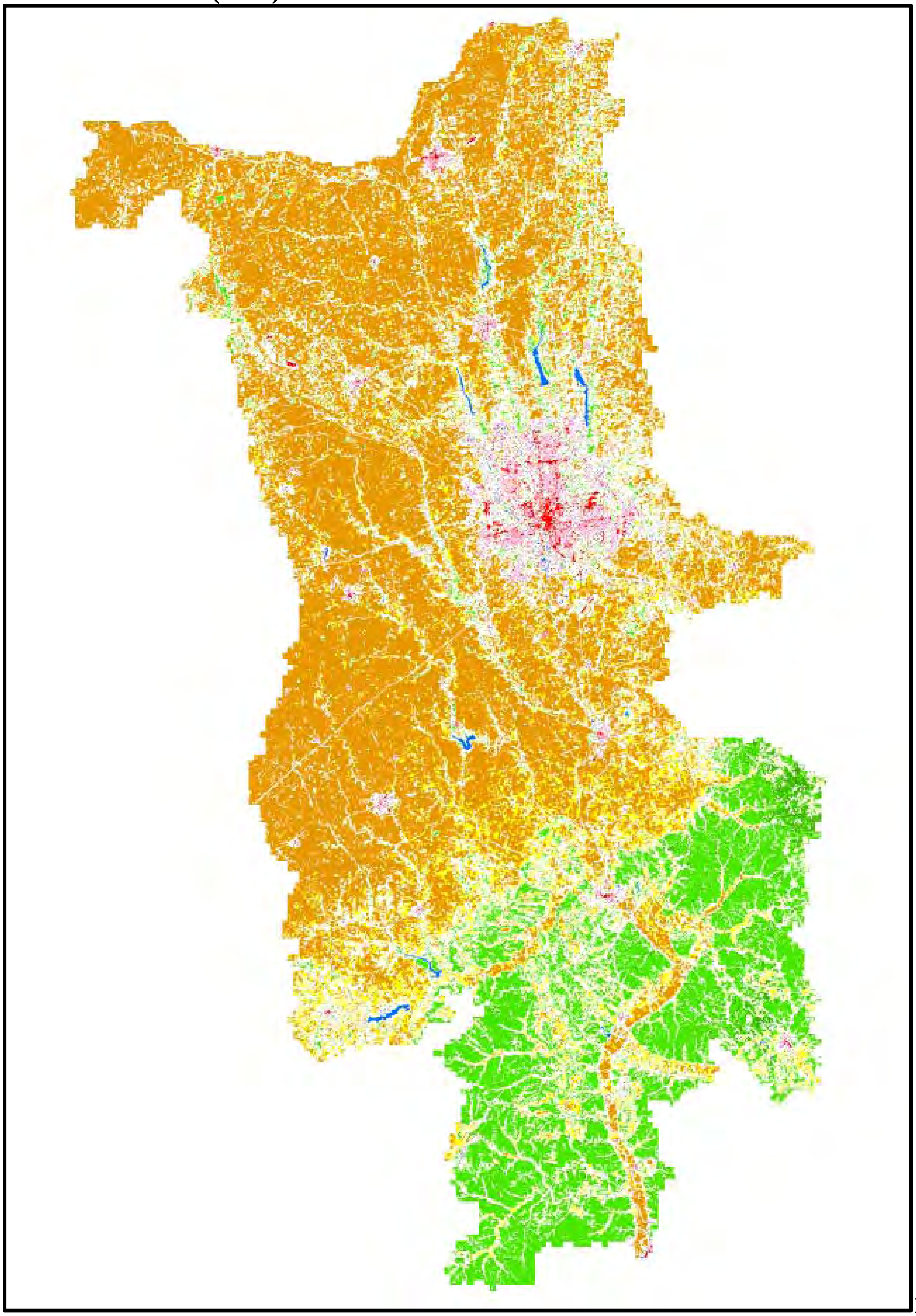


Figure 7. Scioto River sites; ORSANCO (X); 2005.

1.2.4. Scioto River (2005)



1.

Figure 8. Scioto River land use map.

1.2.5. Minnesota River (2006)

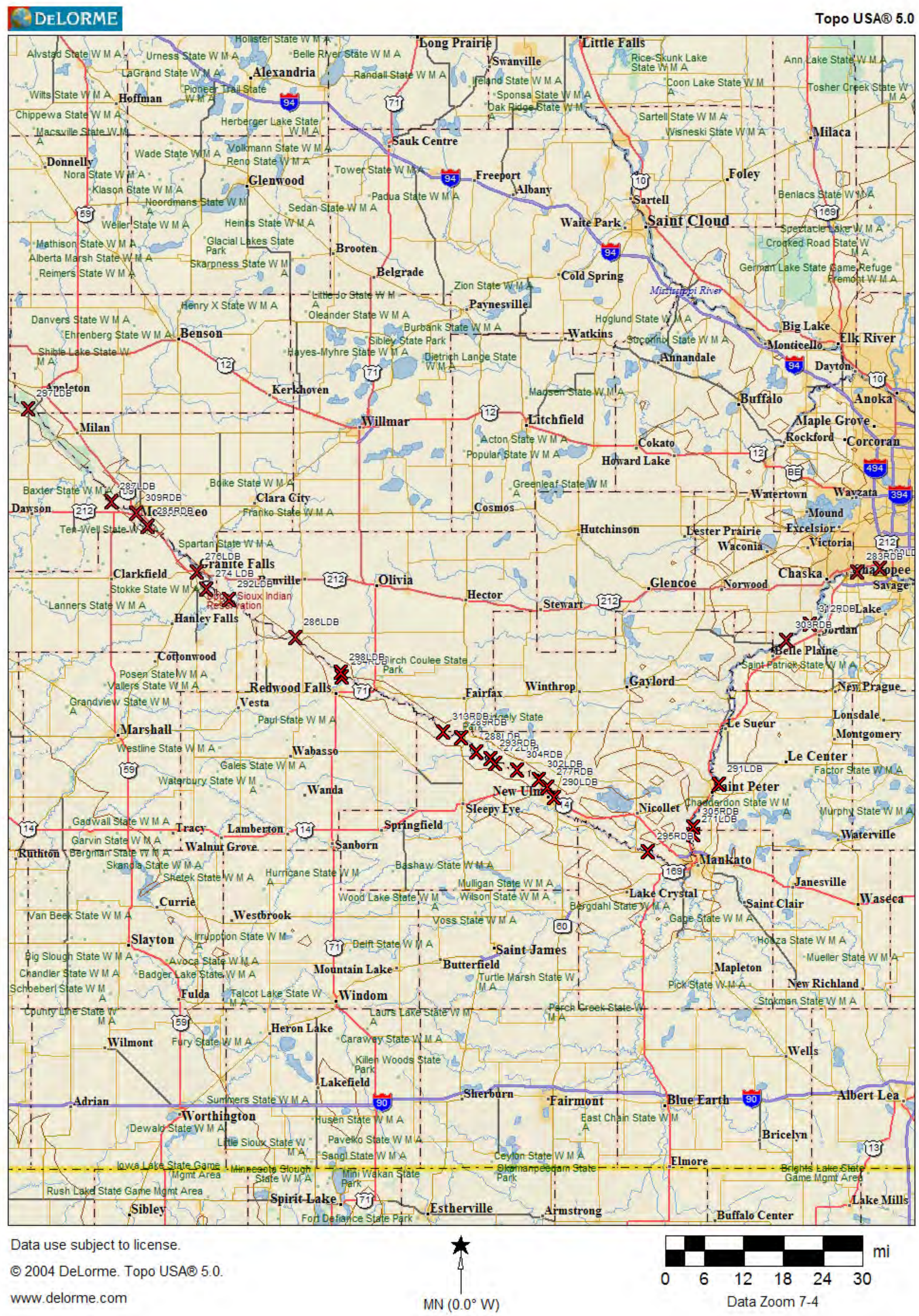


Figure 9. Minnesota River sites; ORSANCO (X); 2006.

1.2.5. Minnesota River (2006)

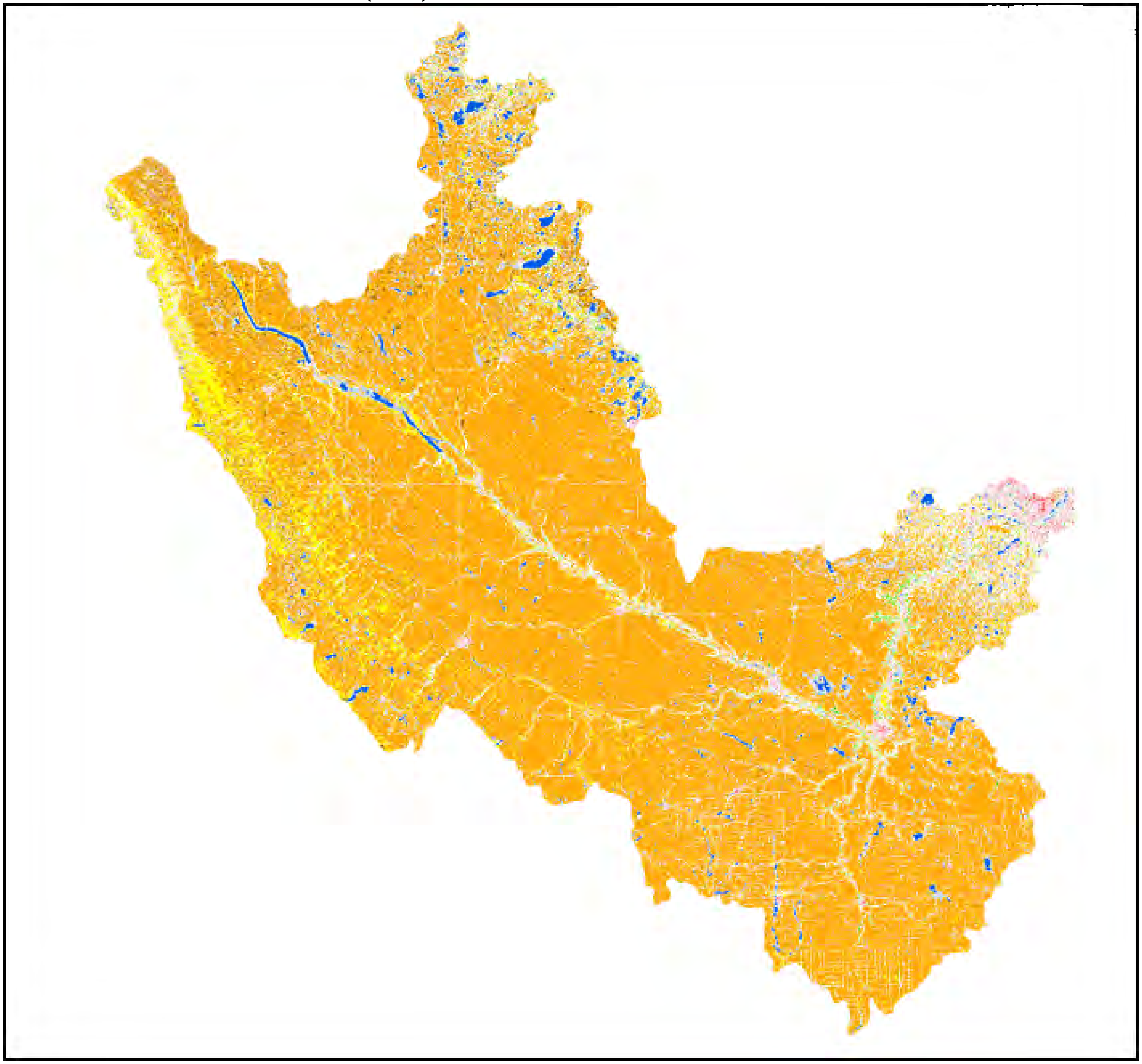


Figure 10. Minnesota River land use map.

1.2.6. Muskingum and Tuscarawas rivers (2006)

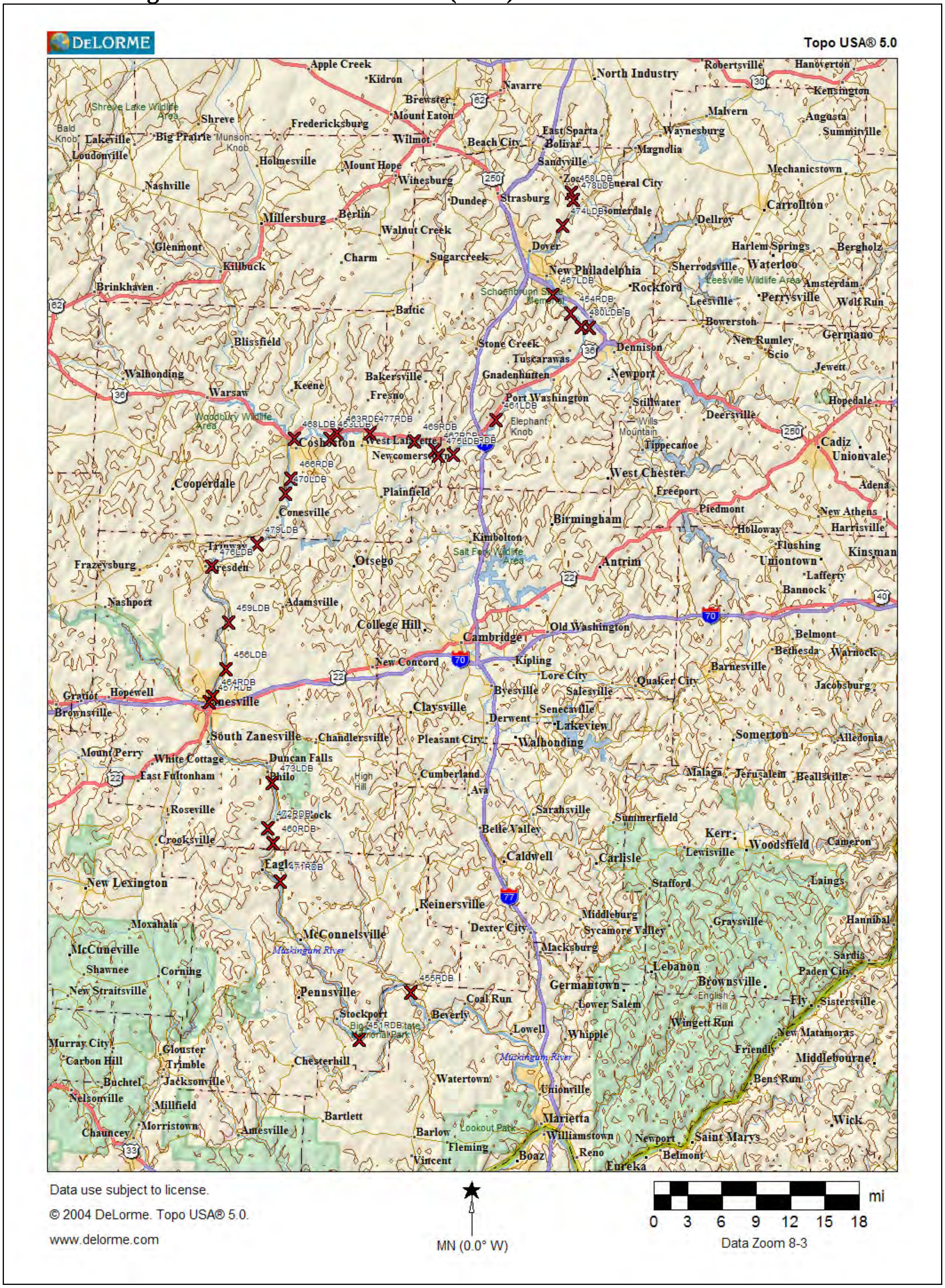


Figure 11. Muskingum and Tuscarawas river sites; ORSANCO (X); 2006.

1.2.6. Muskingum and Tuscarawas rivers (2006)

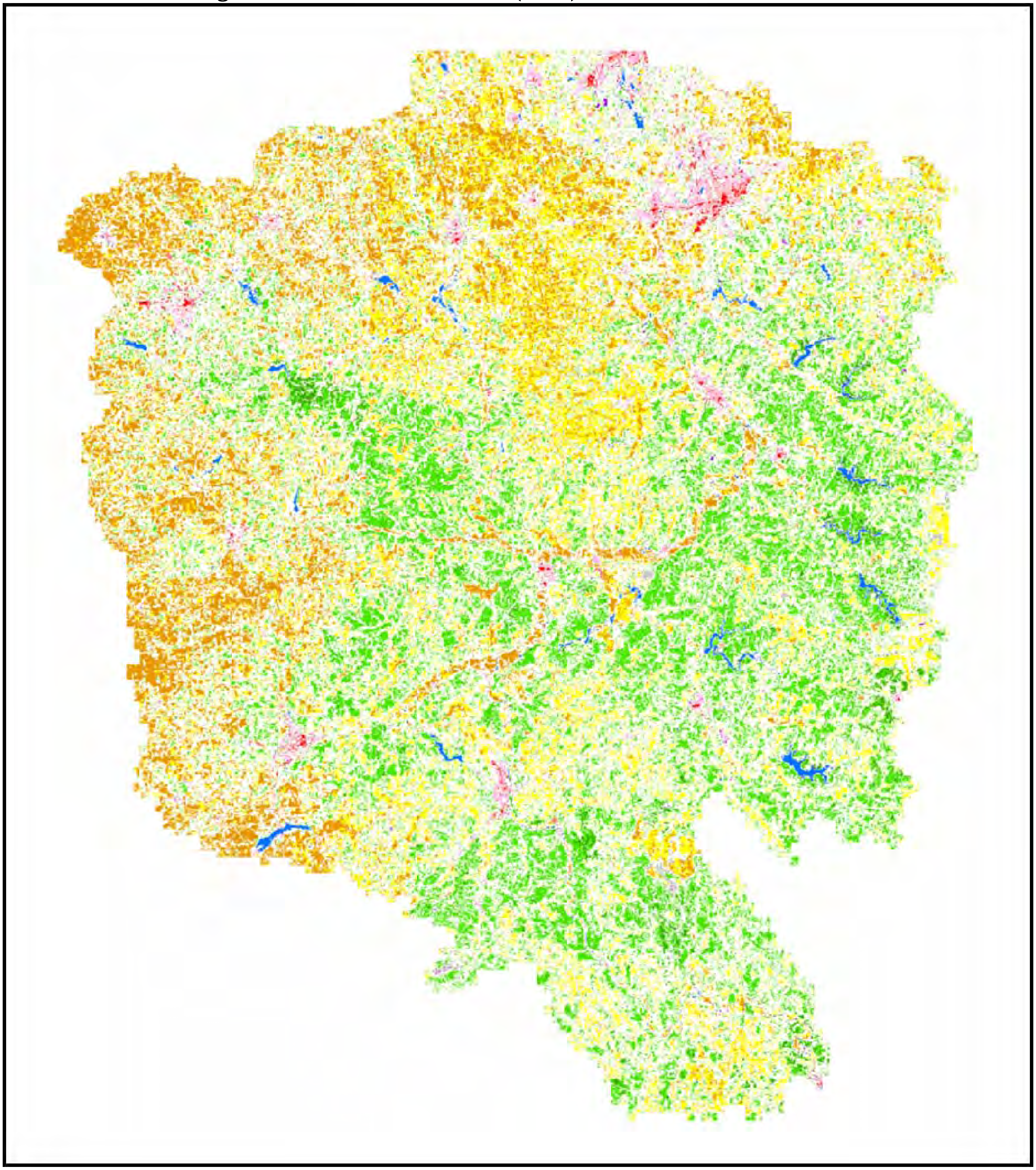


Figure 12. Muskingum and Tuscarawas river land use map.

1.2.7. Illinois River (2006)

Figure 13. Illinois River sites; ORSANCO (X); 2006.

1.2.7. Illinois River (2006)

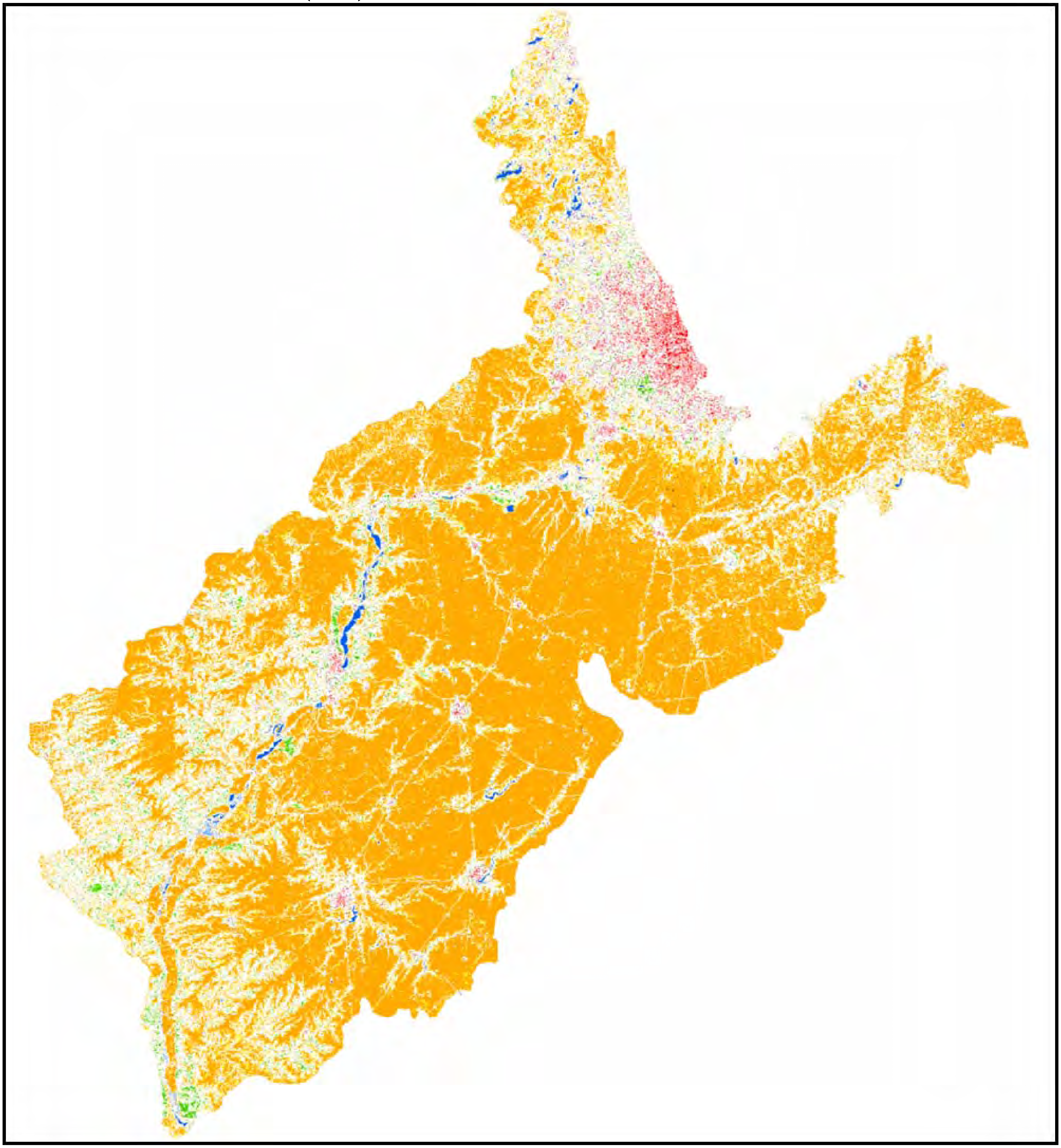


Figure 14. Illinois River land use map.

Figure 15. Land use map color legend.

APPENDIX 2. PROTOCOLS

2.1. ORSANCO ELECTROFISHING SOP

As the rivers assessed in this project exhibit physical differences and unique depth, substrate and littoral habitat profiles, sampling methodologies and gears had to be tailored to meet the requirements of the sites. Specifically, river width, depth and other factors may allow for diurnal movements of fishes. In such cases, night sampling protocols were appropriate and necessary to more accurately ascertain the fish population at a given site. Likewise where riverine structure does not allow for diurnal movements, daytime specific gear was employed.

1.0 FIELD EQUIPMENT

The following equipment is used to conduct electrofishing surveys:

1.1 **Electrofishing Boat Unit**

1.1.1 19-ft. Oquaka® custom aluminum john boat
1.1.2 16-ft. aluminum john boat (day sampling only)
1.1.3 Smith-Root® Type 5.0 GPP Electrofishing Unit
1.1.4 Dual, Retractable Anode Array (night)
1.1.5 Single flip-over Anode Boom (day)
1.1.6 (4) 75-watt floodlamp lighting system (night)
1.1.7 Positive pressure cut-off foot pedal switch
1.1.8 75-gallon plastic "live well" with aerator
1.1.9 Marine radio
1.1.10 Personal LED headlamps (night)
1.1.11 12-Volt 2 million candlepower spotlight (night)

1.2 **Fish Collection**

1.2.1 Fiberglass handled nets with 0.25-in mesh
1.2.2 Rubber boots for each crew member
1.2.3 Personal Floatation Device for each crew member
1.2.4 Rubber gloves for each crew member
1.2.5 Ear protection for each crew member

1.3 **Fish Processing**

1.3.1 Fish identification reference keys
1.3.2 Fish measuring board
1.3.3 Weighing scales
1.3.4 Voucher collection containers
1.3.5 Sorting buckets and trays

1.4 **Water Chemistry Measurements**

1.4.1 YSI® Model 556 Multi-probe Meter
1.4.2 Secchi Disk
1.4.3 Leica® Model LRF 900 Laser Rangefinder

2.0 **Electrofishing Fish Survey Procedures**

2.1 **Training**

2.1.1 Each ORSANCO staff member involved in the electrofishing program will be trained in electrofishing procedures by a staff member having at least one year of electrofishing experience on the Ohio River.

2.1.2 Staff shall perform at least two training sessions to the satisfaction of the Principal Investigator before performing any program sampling.

2.1.3 Each staff member involved in electrofishing activities should be certified in cardiopulmonary resuscitation (CPR) and basic first aid procedures.

2.2 **Field Methods**

2.2.1 **Site Selection**

Sampling zones are selected along the shoreline with the most diverse macrohabitat features within the designated sampling area.

2.2.2 **Zone Measurement**

Electrofishing zones are 0.5-km length. Distances are measured with a Magellan Sportrak Color GPS system and a Leica Rangemaster 900 Laser Rangefinder.

2.2.3 **Zone Delineation**

The boundaries of each electrofishing zone are clearly marked on stationary object (e.g. trees, rocks, etc.) with florescent orange paint and/or orange surveyor's flagging. This enables accurate location of the site on subsequent sampling dates. Care must be taken not to mark objects on private property without consent of the owner.

2.2.4 **Site Indexing**

The location of each sampling zone is indexed by river mile and marked on US COE navigational charts. A Global Positioning System (GPS) is utilized to obtain long/lat coordinates. These coordinates will be used in designating each zone in ORSANCO's Geographic Information System. The coordinates should be taken at the upstream boundary, midpoint, and downstream boundary of the zone.

2.3 **Water Chemistry Parameters**

2.3.1 Dissolved oxygen, conductivity, temperature, pH, and secchi depth are recorded at the upstream end of each electrofishing zone immediately prior to sampling. River stage and general weather conditions will be recorded at this time. This information is recorded at the appropriate locations on the data sheet (Attachment A-1).

2.4 **Fish Sampling Procedures**

2.4.1 **Electrofishing Boat Design**

A description of the electrofishing boat is given in Section 1.1

2.4.2 **Smith-Root Type 5.0 GPP Electrofisher Settings**

The Ohio River's relative conductivity values normally range from 280 to 330 mmhos/cm. This generally results in a voltage selection of 354 volts dc at 60 pulses/ second with a pulse width of 4. These settings will generally produce the target amperage of 8 amperes. The operator may adjust pulse width to produce 8 amperes if necessary; other setting should not need changing. The operator may try higher voltage settings at lower conductivity readings and lower voltage settings at higher conductivity readings to obtain the desired 8 amperes.

2.4.3 **Pulsed DC Electrofishing**

Pulsed DC is transmitted through the water by a Standard Straight electrode array. The safety aspects of this type of apparatus are a positive pressure cut-off switch located on the bow of the boat controlled by a netter and an emergency shut-down switch held by the operator of the boat.

2.4.4 The surveys will be conducted at night beginning just after dusk. Night electrofishing is conducted because of the increased foraging that occurs along the shoreline in the evening hours. Night electrofishing also eliminates glare that may result in fish not being collected. Lighting is supplied by six 75-watt flood bulbs attached to the bow railing of the boat, powered by the onboard generator.

2.4.5 Individual sampling zones are electrofished from upstream to downstream by slowly and steadily maneuvering the boat close to the shore and structure in a "zig zag" pattern.

2.4.6 Time electrofished (seconds) is recorded from the electrofisher time meter immediately after electrofishing. A mean of 1800 seconds is required to provide a sufficient sample. More time may be necessary for zones that incorporate more complex habitats such as those with extensive woody cover such as logs or stumps. Less time may be acceptable for zones that exhibit fast flow and/or minimal structure or instream cover.

2.4.7 A sampling crew consists of two netters and a driver. All personnel are clad in rubber boots, ear protectors, and a Type I personal floatation device. The netters also wear rubber gloves.

2.4.8 As the driver maneuvers the boat through the electrofishing zone, the netters remove the stunned fish from the water. The fish are then placed into the live well to be processed immediately after electrofishing.

2.4.9 It is recommended that sampling take place under stable, low-flow conditions at a stage level within 1m of ‘normal, flat pool’, and when secchi depths are at least 0.3m.

3.0 **Fish Processing Procedures**

3.1 Fish are sorted into five-gallon buckets by family or species

3.2 Processing priority is as follows:

1. threatened and/or endangered species
2. game species
3. general population

3.3 Total length of each fish is measured to the nearest millimeter using a standard 1.0 meter fish measuring board.

3.4 Total weight of each fish is recorded to the nearest gram using either a 1.0-kg scale or a 4.0-kg scale, depending on the weight of the fish.

3.5 Small individuals of a given species may be sorted into 3-cm size classes and a total weight recorded for all individuals. Large fish (>30-cm) should be measured and weighed individually, even if in large numbers.

3.6 All areas of the data sheet are filled out completely and legibly for each individual or size class.

4.0 **Fish Disposal Procedures**

4.1 All living specimens, except voucher and questionable specimens are returned to the water.

4.2 Fish not surviving will be buried on shore or returned to deep water for "nutrient recycling". If many fish are not surviving, the project leader must investigate probable causes and implement immediate corrective action. Probable causes to be examined (but not limited to) are:

1. lack of sufficient aeration,
2. fish processing not quick enough,
3. fish handled improperly, and/or
4. electrofisher settings incorrect (Section 2.4.2).

5.0 **Data Handling and Analysis**

5.1 Field data sheets are collected at the conclusion of each study by the Principal Investigator. Upon return to the office, copies are produced and forwarded to participating state agency personnel upon request

5.2 ORSANCO staff compiles and reviews the data prior to entry into the ORSANCO data base. Data reduction procedures are documented in the Boat Electrofishing Population Survey Quality Assurance Program Plan, Section 9.

5.3 For specific routine procedures to assess the data, see Section 12 of the Boat Electrofishing Population Survey Quality Assurance Program Plan.

6.0 **Reference and Voucher Collections**

6.1 All voucher specimens will be retained at ORSANCO headquarters for a period of not less than two years.

6.2 Any species contained in the voucher collection but not in the reference collection will be properly labeled and added to the reference collection.

6.3 The reference collection will be stored at ORSANCO headquarters.

7.0 **References**

Kolz, A.L., J.B. Reynolds, and J. Boardman. 1991. Principles and Techniques of Electrofishing.
U. S. Fish & Wildlife Service Instructional Course Packet #2101

Ohio Environmental Protection Agency. 1989. Biological Criteria for the protection of aquatic life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for assessing Fish and Macroinvertebrate Communities. Division of Water Quality Monitoring and Assessment. Columbus, Ohio.

Pflieger, W.L. 1975. The Fishes of Missouri. Western Publishing Co. 343 pp.

Tennessee Valley Authority. 1987. Field Operations Biological Resources Procedures Manual. Tennessee Valley Authority, Division of Natural Resource Operations. Knoxville, Tennessee.

Trautman, M.B. 1981. The Fishes of Ohio. Revised Edition. Ohio State University Press. Columbus, Ohio. 782 pp.

4439624710 **ORSANCO Electrofishing Field Data Sheet**

River: OH10 | Site ID: 0025 | Date (Month / Day / Year): 07 / 01 / 04

River Mile: 123.4 | Minnow Jars: Y N (Y) | Begin Time (Hour : Min.): 10 : 00

Bank: RBD/LDB: LDB | End Time: 10 : 45

Zone Length: 500 | Crew Leader: EBE | Total Sec.: 2105

Page 1 of 2 | Crew Members: MSW, JAT | Secchi (in): 18

pH: 8.10 | DO (mg/L): 8.7 | Temp (C): 21.5 | Cond (mS/cm): 300

Species	DELT	Sp Code	Count	Size Class	Weight (Kg)
Sauger		177.5	1	11	0.275
SM Bass	ER	165.5	1	10	0.350
SM Bass		165.5	3	06	0.300
LN Gar		030.1	1	20	0.490
Longear SF		164.5	3	04	0.095
SM Buffalo		107.1	1	15	1.300
		.			.
		.			.
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Figure 16. ORSANCO Electrofishing Datasheet / Fish assessment field sheet showing how catch and site data are recorded.

2.2. HABITAT SOPs

2.2.1. ORSANCO PHYSICAL HABITAT ASSESSMENT SOP

INTRODUCTION

This document describes the procedures for ORSANCO's Habitat Data Collection. This SOP has been developed to maintain continuity and ensure the quality of the data collected.

1.0 FIELD EQUIPMENT

The following equipment is used to conduct the habitat surveys:

1.1 **Boat Unit**

1.1.1 18-ft. aluminum john boat

1.1.2 two 10-ft ¾ in. copper poles capped at one and wrapped with marking tape at each one foot interval along the length of the pole. One pole has a male adapter and the other has a female adapter

1.1.3 100 ft rope marked at 10 ft intervals with a 5 lb weight on one end

1.1.4 Marine radio

2.0 Habitat Data Collection Procedures

2.1 **Training**

2.1.1 Each ORSANCO staff member involved in the habitat data collection program will be trained in collection procedures by a staff member having at least one year of habitat data collection experience on the Ohio River.

2.1.2 Staff shall perform at least two training sessions to the satisfaction of the Principal Investigator before performing any program sampling.

2.**2 Field Methods**

2.2.1 Site Selection

Sampling zones are selected along the shoreline with the most diverse macrohabitat features within the designated sampling area.

2.2.2 Zone Measurement

Electrofishing zones are 0.5-km length. Distance is measured with a Magellan Sportrack Color handheld GPS unit and a Leica LRF 900 laser rangefinder. Sampling Zones are measured by navigating to the top or upstream end of the electrofishing zone, marking the start point in the GPS unit while simultaneously measuring distance from shore with the laser rangefinder. These two pieces of equipment are used to measure the length of the zone and distance from shore while slowly maneuvering the boat to the end of the zone.

2.2.3 Zone Delineation

The boundaries of each electrofishing zone are clearly marked on stationary object (e.g. trees, rocks, etc.) with florescent orange paint and/or orange surveyor's flagging. This enables accurate location of the site on subsequent sampling dates. Care must be taken not to mark objects on private property without consent of the owner.

2.2.4 Site Indexing

The location of each sampling zone is indexed by river mile and marked on US COE navigational charts when applicable. A Global Positioning System (GPS) will be used to obtain long/lat coordinates. These coordinates will be used in designating each zone in ORSANCO's Geographic Information System. The coordinates should be taken at the upstream boundary, midpoint, and downstream boundary of the zone.

2.3 Habitat Data Collection Procedure

2.3.1 Beginning at shoreline at the upstream end of the zone, one crew member takes/ records a GPS mark at the water’s edge. The sediment at the shoreline is recorded. The driver then slowly backs the boat away from shore in a straight line perpendicular to the shoreline, as a crewmember maintains a fix on the target point with the rangefinder and calls off distance to shore. At each 10 ft interval sediment and depth are recorded by lowering one end of the copper pole to the substrate. Sediment and depth are recorded every 10 ft to 100 ft out from shore. This procedure is repeated at each of the six 100 m marks of the zone, starting at the upper end and finishing at the lower.

3.0 Data Handling and Analysis

3.1 Field data sheets are collected at the conclusion of each study by the Principal Investigator.

3.2 ORSANCO staff compiles and reviews the data prior to entry into the ORSANCO data base.

River: ____________ Description: ______________________________

Rmi: ____________ ______________________________

Bank: ____________ GPS lat: ______________ GPS long: ______________

Point on Shore	DFS	Depth	B	C	G	S	F	H
0	0	0						
0	10							
0	20							
0	30							
0	40							
0	50							
0	60							
0	70							
0	80							
0	90							
0	100							
100	0	0						
100	10							
100	20							
100	30							
100	40							
100	50							
100	60							
100	70							
100	80							
100	90							
100	100							
200	0	0						
200	10							
200	20							
200	30							
200	40							
200	50							
200	60							
200	70							
200	80							
200	90							
200	100							

Point on Shore	DFS	Depth	B	C	G	S	F	H
300	0	0						
300	10							
300	20							
300	30							
300	40							
300	50							
300	60							
300	70							
300	80							
300	90							
300	100							
400	0	0						
400	10							
400	20							
400	30							
400	40							
400	50							
400	60							
400	70							
400	80							
400	90							
400	100							
500	0	0						
500	10							
500	20							
500	30							
500	40							
500	50							
500	60							
500	70							
500	80							
500	90							
500	100							

Figure 17. ORSANCO Habitat Field Sheet (front).

Channel Morphology — Inside Bend ☐ Outside Bend ☐ Straight Stretch ☐ Backchannel ☐

						Average Depth at Cover Type				
						0-100	1-200	2-300	3-400	4-500
Overhanging Vegetation %	0-100	100-200	200-300	300-400	400-500	0-100	1-200	2-300	3-400	4-500
Submerged Brush %	0-100	100-200	200-300	300-400	400-500	0-100	1-200	2-300	3-400	4-500
Submerged Stumps %	0-100	100-200	200-300	300-400	400-500	0-100	1-200	2-300	3-400	4-500
Submerged logs/trees %	0-100	100-200	200-300	300-400	400-500	0-100	1-200	2-300	3-400	4-500
Submerged Aq. Veg. %	0-100	100-200	200-300	300-400	400-500	0-100	1-200	2-300	3-400	4-500

Riparian Area (50m back from shore)

Immediate land use — Crops ☐ Forest ☐ Rip Rap ☐ Industry ☐ Lawns ☐ Pasture ☐ Road/RR ☐

Density of vegetation — Trees Only ☐ Undergrowth Only ☐ Trees and Undergrowth ☐ None ☐

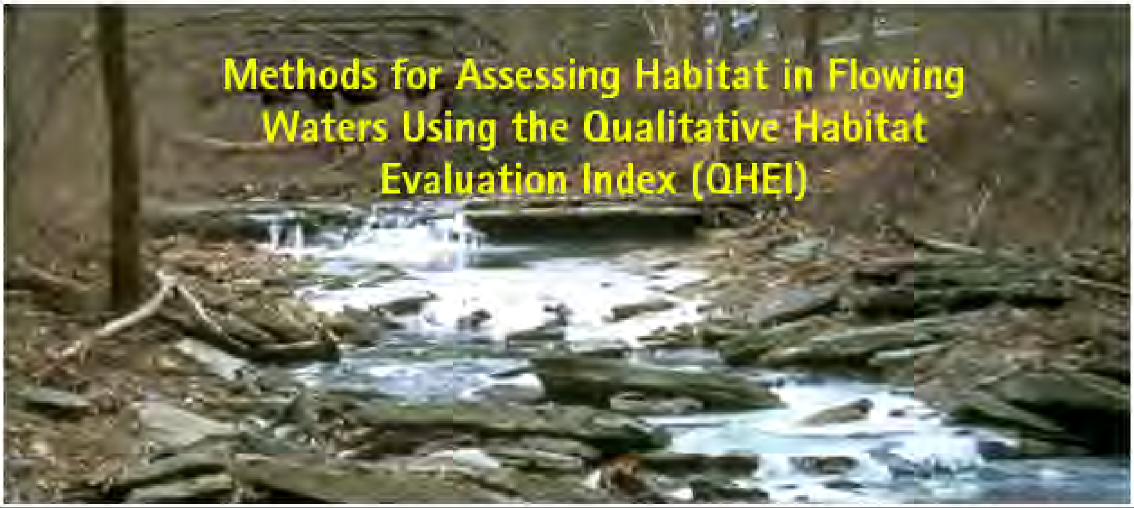
Height of vegetation — <2ft ☐ 2-5ft ☐ 5-20ft ☐ >20ft ☐

Human Influences — Barges ☐ Instream Manmade Structure ☐ Other ____________

Bank Stability — Stable w/ est. veg. ☐ Eroded ☐

Figure 18. ORSANCO Habitat Field Sheet (back).

2.2.2. QHEI PROTOCOL / QHEI MANUAL



Introduction

This document summarizes the methodology for completing a general evaluation of macrohabitat, generally done by the fish field crew leader while sampling each location using the Ohio EPA Site Description Sheet - Fish (Figure V-4-5). This form is used to tabulate data and information for calculating the Qualitative Habitat Evaluation Index (QHEI). The following guidance should be used when completing the site evaluation form.

Geographical Information

1) Stream, River Mile (RM), Date.

The official stream name may be found in the Gazetteer of Ohio Streams (Ohio DNR, 1960) or on USGS 7.5 minute topographic maps. If the stream is unnamed, a name and stream code is assigned by the Ohio ECOS Database Coordinator. Usually the name of a nearby landmark is used for the stream name. A basin-river code is also assigned from the ECOS river code system. The River Mile (RM) designations used are found on 7.5 minute topo maps stored at the Ohio EPA, Division of Surface Water, Lazarus Government Center, Front Street (PEMSO RMI maps), one of five Ohio EPA District offices (maps for that district), and the Ohio EPA, Ecological Assessment Section at Grove City.

2) Specific Location

A brief description of the sampling location should include proximity to a local landmark such as a bridge, road, discharge outfall, railroad crossing, park, tributary, dam, etc.

3) QHEI Scorers Initials/ Institution

The initials of the person who filled out the sheet are listed, along with the institution, company etc. If forms have not been submitted previously, supply the full name of the scorer. QHEI information is to be completed someone who has successfully completed the QHEI training (e.g, crew leader).

Habitat Characteristics: QHEI Metrics

The Qualitative Habitat Evaluation Index (QHEI) is a physical habitat index designed to provide an empirical, quantified evaluation of the general lotic macrohabitat characteristics that are important to fish communities. A detailed analysis of the development and use of the QHEI is available in Rankin (1989) and Rankin (1995). The QHEI is composed of six principal metrics each of which are described below. The maximum possible QHEI site score is 100. Each of the metrics are scored individually and then summed to provide the total QHEI site score. This is completed at least once for each sampling site during each year of sampling. An exception to this convention would be when substantial changes to the macrohabitat have occurred between sampling passes. Standardized definitions for pool, run, and riffle habitats, for which a variety of existing definitions and perceptions exist, are essential for accurately using the QHEI. For consistency the following definitions are taken from Platts et al. (1983). It is recommended that this reference also be consulted prior to scoring individual sites.

Riffle and Run Habitats:

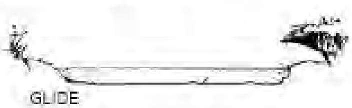
Riffle - areas of the stream with fast current velocity and shallow depth; the water surface is visibly broken.

Run - areas of the stream that have a rapid, non-turbulent flow; runs are deeper than riffles with a faster current velocity than pools and are generally located downstream from riffles where the stream narrows; the stream bed is often flat beneath a run and the water surface is not visibly broken.

Pool and Glide Habitats:

Pool - an area of the stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.

Glide - this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero.



HINT: These habitat types typically grade into one another. For example a run gradually changes into a pool.

When measuring typical depths of these features take measurements where the feature is clearly of that type, not where they are grading from one type to another.

Above: A stream where physical habitat is the obvious limiting variable fro aquatic life.

The following is a description of each of the six QHEI metrics and the individual metric components. Guidelines on how to score each is presented. Generally, metrics are scored by checking boxes. In certain cases the biologist completing the QHEI sheet may interpret a habitat characteristic as being intermediate between the possible choices; in cases where this is allowed (denoted by the term "Double-Checking") two boxes may be checked and their scores averaged.

Metric 1: Substrate

This metric includes two components, substrate type and substrate quality.

Substrate type

Check the two most common substrate types in the stream reach. If one substrate type predominates (greater than approximately 75-80% of the bottom area OR what is clearly the most functionally predominant substrate) then this substrate type should be checked twice. **DO NOT CHECK MORE THAN TWO BOXES**. Note the category for artificial substrates. Spaces are provided to note the presence (by check marks, or estimates of % if time allows) of all substrate types present in pools (includes pools and glides) and riffles (includes riffles and runs) that each comprise at least 5% of the site (*i.e.*, they occur in sufficient quantity to support species that may commonly be associated with the habitat type). This section must be filled out completely to permit future analyses of this metric. If there are more than four substrate types in the zone that are present in greater than approximately 5% of the sampling area check the appropriate box.

Substrate quality

Substrate origin refers to the 'parent' material that the stream substrate is derived from. Check ONE box under the substrate origin column unless the parent material is from multiple sources (e.g., limestone and tills). *Embeddedness* is the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials (sand and silt).

Side view of unembedded and embedded substrates

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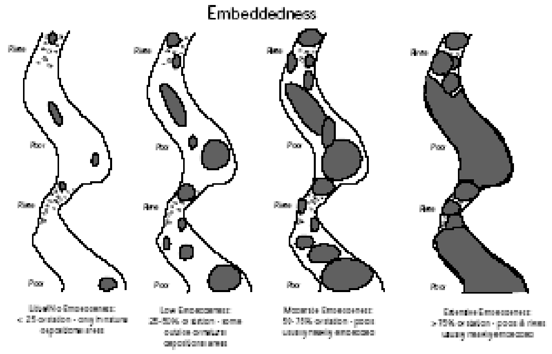
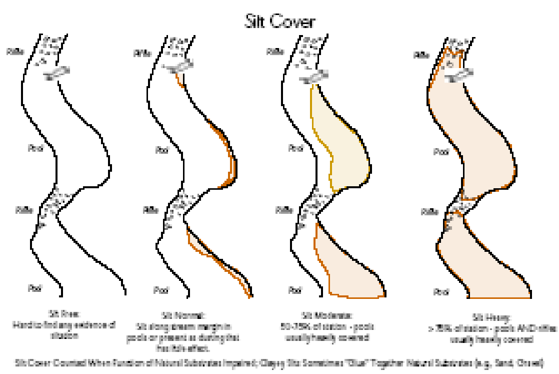
Substrates should be considered embedded if >50% of surface of the substrates are embedded in



fine material. Embedded substrates cannot be easily dislodged. This also includes substrates that are concreted or "armor-plated". Naturally sandy streams are not considered embedded; however, a sand predominated stream that is the result of anthropogenic activities that have buried the natural coarse substrates is considered embedded. Boxes are checked for extensiveness (*i.e.*, pervasiveness, area of sampling zone) of



the embedded substrates as follows: Extensive — > 75% of site area, Moderate — 50-75%, Sparse — 25-50%, Low — < 25%.

Silt Cover is the extent that substrates are covered by a silt layer (*i.e.*, an 1 inch thick or obviously affecting aquatic habitats). **Silt Heavy** means that nearly all of the stream bottom is layered with a deep covering of silt. **Moderate** includes extensive coverings of silts, but with some areas of cleaner substrate (*e.g.*, riffles). **Normal** silt cover includes areas where silt is deposited in small amounts along the stream margin or is present as a "dusting" that appears to have little functional significance. If substrates are exceptionally clean the **Silt Free** box should be checked.

Substrate types are defined as:

a) **Bedrock** - solid rock forming a continuous surface.

b) **Boulder** - rounded stones over 256 mm in diameter(10 in.) or large "slabs" more than 256 mm in length (Boulder slabs).

c) **Cobble** - stones from 64-256 mm (2 1/2 - 10 in.) in diameter.

d) **Gravel** - mixture of rounded course material from 2-64 mm (1/12 - 2 1/2 in.) in diameter.

e) **Sand** - materials 0.06 - 2.0 mm in diameter, gritty texture when rubbed between fingers.

f) **Silt** - 0.004 - 0.06 mm in diameter, generally this is fine material which feels "greasy" when rubbed between fingers.

g) **Hardpan** - particles less than 0.004 mm in diameter, usually clay, which forms a dense, gummy surface that is difficult to penetrate.

h) **Marl** - calcium carbonate; usually greyish-white; often contains fragments of mollusc shells.

i) **Detritus** - dead, unconsolidated organic material covering the bottom which could include sticks, wood and other partially or undecayed coarse plant material.

j) **Muck** - black, fine, flocculent, completely decomposed organic matter (does not include sewage sludge).

k) **Artificial** - substrates such as rock baskets, gabions, bricks, trash, concrete etc., placed in the stream for reasons OTHER than habitat mitigation

Sludge is defined as a thick layer of organic matter, that is decidedly of human or animal origin. NOTE: SLUDGE THAT ORIGINATES FROM POINT SOURCES IS NOT INCLUDED; THE SUBSTRATE SCORE IS BASED ON THE UNDERLYING MATERIAL. This scenario is rare today and was done to prevent underestimating stream habitat potential affect by discharges.

Substrate Metric Score:

Although the sum of the individual metric scores can be greater than 20 the maximum substrate core allowed for this metric is 20 points.

Metric 2: Instream Cover

This metric scores presence of instream cover types and amount of overall instream cover. Each cover type that is present in greater than approximately 5% of the sampling area (i.e., occurs in sufficient quantity to support species that may commonly be associated with the habitat type) should be checked. Cover should

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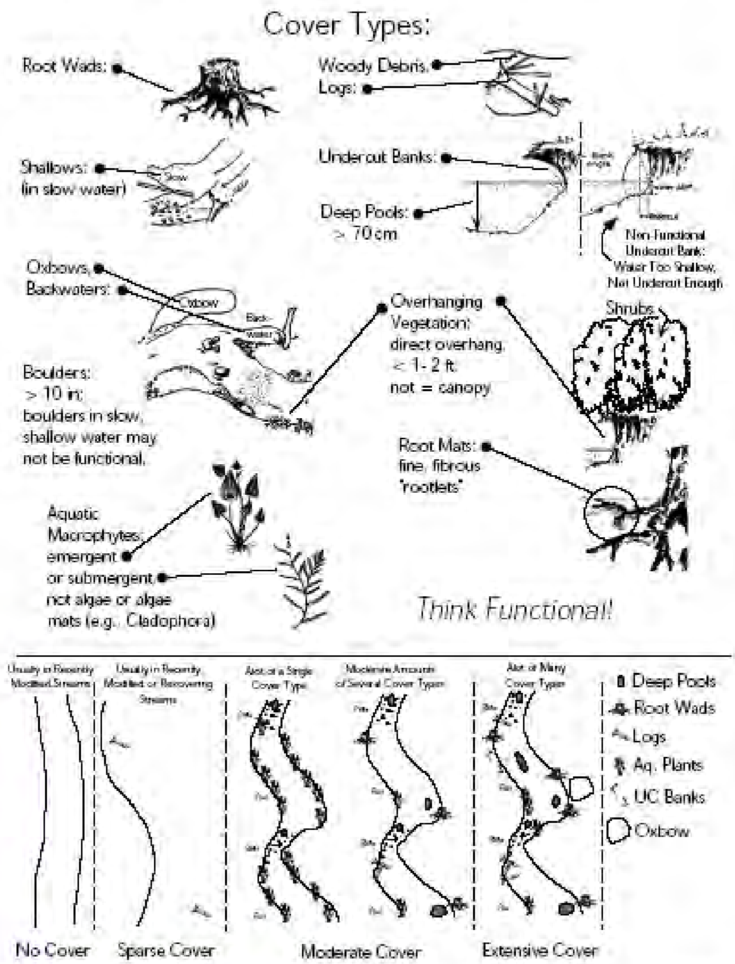
not be counted when it is in areas of the stream with insufficient depth (usually < 20 cm) to make it useful. For example a logjam in 5 cm of water contributes very little, if any cover, and at low flow may be dry. Other cover types with limited function in shallow water include undercut banks and overhanging vegetation, boulders, and rootwads. Under amount, one or two boxes may be checked. Extensive cover is that which is present throughout the sampling area, generally greater than about 75% of the stream reach. Cover is moderate when it occurs over 25-75% of the sampling area. Cover is sparse when it is present in less than 25% of the stream margins (sparse cover usually exists in one or more isolated patches). Cover is nearly absent when no large patch of any type of cover exists anywhere in the sampling area.

Woody debris is an important cover type in all streams, but especially in low gradient streams.

This situation is usually found in recently channelized streams or other highly modified reaches (e.g. ship channels). If cover is thought to be intermediate in amount between two categories, check two boxes and average their scores. For wide streams cover amount is estimated along the swath of stream sampled (or that would be sampled) with an electrofisher. In smaller streams (smaller wadeable and headwater

Examples of typical cover types that occur in Ohio streams.



Rootwads formed by Sycamore trees are one of the finest forms of cover found in Ohio streams.

streams) this generally covers most of the stream width. Cover types include: 1) undercut banks, 2) overhanging vegetation, 3) shallows (in slow water), 4) logs or woody debris, 5) deep pools (> 70 cm), 6) oxbows, 7) boulders, 8) aquatic macrophytes, and 9) rootwads (tree roots that extend into stream). Do not check undercut banks AND rootwads unless undercut banks exist along with rootwads as a major component. Although the theoretical maximum score is > 20 the maximum score assigned for the QHEI for the instream cover metric is limited to 20 points

Metric 3: Channel Morphology

Table 1: Scoring criteria for pool/riffle development metric.

	Excellent	Good	Fair	Poor
Pool	> 1 m deep, well defined	0.7-1.0 m deep, well defined	Some depth variation	Shallow, if present
Glide	Not common	Not common	Common	Predominant
Riffle	Deep, well defined riffles, large substrates	Defined riffles, large substrates	Poorly defined riffles or riffles absent	Absent of shallow with fine substrates
Run	> 0.5 m deep, well defined	Deep, well defined	Usually absent	Absent

This metric can be double-checked. For situations, for example where riffles are excellent and pools are only fair, it is advantageous to check the excellent and the fair box rather than checking the good box as an average to keep information on the variance in quality.

This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (i.e. the degree to which the stream meanders), channel development, channelization, and channel stability. One box under each should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

a) *Sinuosity* - **No sinuosity** is a straight channel. **Low sinuosity** is a channel with only 1 or 2 poorly defined outside bends in a sampling reach, or perhaps slight meandering within modified banks. **Moderate sinuosity** is more than 2 outside bends, with at least one bend well defined. **High sinuosity** is more than 2 or 3 well defined outside bends with deep areas outside and shallow areas inside. Sinuosity may be more conceptually described by the ratio of the stream distance between two points on the channel of a stream and the straight-line distance between these same two points, taken from a topographic map. Check only one box.

Note how well defined (*i.e.*, distinct) the riffle and pool are in this high quality headwater stream. Also note the large tree in the riparian..

b) *Development* - This refers to the development of riffle/pool complexes. **Poor** means riffles are absent, or if present, shallow with sand and fine gravel substrates; pools, if present are shallow. Glide habitats, if predominant, receive a **Poor** rating. **Fair** means riffles are poorly developed or absent; however, pools are more developed with greater variation in depth. **Good** means better defined riffles present with larger substrates (gravel, rubble or boulder); pools have variation in depth and there is a distinct transition between pools and riffles. **Excellent** means development is similar to the **Good** category except the following characteristics must be present: pools must have a maximum depth of >1 m and deep riffles and runs (>0.5 m) must also be present. In streams sampled with wading methods, a sequence of riffles, runs, and pools must occur more than once in a sampling zone. Check one box.

c) *Channelization* - This refers to anthropogenic channel modifications. **Recovered** refers to streams that have been channelized in the past, but which have recovered most of their natural channel characteristics. **Recovering** refers to channelized streams which are still in the process of regaining their former, natural characteristics; however, these habitats are still degraded. This category also applies to those streams, especially in the Huron/Erie Lake Plain ecoregion (NW Ohio), that were channelized long ago and have a riparian border of mature trees, but still have Poor channel characteristics. **Recent** or **No Recovery** refers to streams that were recently channelized or those that show no significant recovery of habitats (e.g. drainage ditches, grass lined or rock rip-rap banks, etc.). The specific type of habitat modification is checked in the last two columns but not scored.

d) *Stability* - This refers to channel stability. Artificially stable (concrete) stream channels receive a High score. Even though they are generally a negative influence on fish the negative effects are related to features other than their stability. Channels with **Low stability** are usually characterized by fine substrates in riffles that often change location, have unstable and severely eroding banks, and a high bedload that slowly creeps downstream. Channels with **Moderate stability** are those that appear to maintain stable riffle/pool and channel characteristics, but which exhibit some symptoms of instability, e.g. high bedload, eroding or false banks, or show the effects of wide fluctuations in water level. Channels with **High stability** have stable banks and substrates, and little or no erosion and bedload.

e) *Modifications/Other* - Check the appropriate box if impounded, islands present, or leveed (these are not included in the QHEI scoring) as well as the appropriate source of habitat modifications.

The maximum QHEI metric score for Channel Morphology is 20 points.

Metric 4: Riparian Zone and Bank Erosion

This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components require scoring the left and right banks (looking downstream). The average of the left and right banks is taken to derive the component value. One box per bank should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

a) *Riparian Width* - This is the width of the riparian (stream side) vegetation. Width estimates are only done for **forest, shrub, swamp**, and **old field vegetation** if it has **woody** components (e.g., willows). Old field refers to the a fairly mature successional field that has stable, <u>woody plant growth</u>; this generally does not include weedy urban or industrial lots that often still have high runoff potential. Two boxes, one each for the left and right bank (looking downstream), should be checked and then averaged.

b) *Floodplain Quality* - The two most predominant floodplain quality types should be checked, one each for the left and right banks (includes urban, residential, etc.), and then averaged. By floodplain we mean the areas immediately outside of the riparian zone or greater than 100 feet from the stream, whichever is wider on each side of the stream. These are areas adjacent to the stream that can have direct runoff and erosional effects during normal wet weather. We do not limit it to the riparian zone and it is much less encompassing than the stream basin.

c) *Bank Erosion* - The following Streambank Soil Alteration Ratings from Platts et al. (1983) should be used; check one box for each side of the stream and average the scores. False banks are used in the sense of Platts et al. (1983) to mean banks that are no longer adjacent to the normal flow of the channel but have been moved back into the floodplain most com-

River with variable width riparian vegetation. Adjacent landuse is that outside of immediate riparian zone. One side is obviously rowcrop, the other side may be newfield or is perhaps grazed..

monly as a result of livestock trampling.

The role of bank erosion in sediment delivery to streams is often underestimated.

1) **None** - streambanks are stable and not being altered by water flows or animals (e.g. livestock) - Score 3.

2) **Little** - streambanks are stable, but are being lightly altered along the transect line; less than 25% of the streambank is receiving any kind of stress, and if stress is being received it is very light; less than 25% of the streambank is false, broken down or eroding - Score 3.

3) **Moderate** - streambanks are receiving moderate alteration along the transect line; at least 50 percent of the streambank is in a natural stable condition; less than 50% of the streambank is false, broken down or eroding; false banks are rated as altered - Score 2.

4) **Heavy** - streambanks have received major alterations along the transect line; less than 50% of the streambank is in a stable condition; over 50% of the streambank is false, broken down, or eroding - Score 1.

5) **Severe** - streambanks along the transect line are severely altered; less than 25% of the streambank is in a stable condition; over 75% of the streambank is false, broken down, or eroding - Score 1.

The maximum score for Riparian Zone and Erosion metric is 10 points.

Metric 5: Pool/Glide and Riffle-Run Quality

This metric emphasizes the quality of the pool, glide and/or riffle-run habitats. This includes pool depth, overall diversity of current velocities (in pools and riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality.

A) Pool/Glide Quality

1) *Maximum depth* of pool or glide; check one box only (Score 0 to 6). Pools or glides with maximum depths of less than 20 cm are considered to have lost their function and the total metric is scored a 0. No other characteristics need be scored in this case.

2) *Current Types* - check each current type that is present in the stream (including riffles and runs; score -2 to 4), definitions are:

Torrential - extremely turbulent and fast flow with large standing waves; water surface is very broken with no definable, connected surface; usually limited to gorges and dam spillway tailwaters.

Fast - mostly non-turbulent flow with small standing waves in riffle-run areas; water surface may be partially broken, but there is a visibly connected surface.

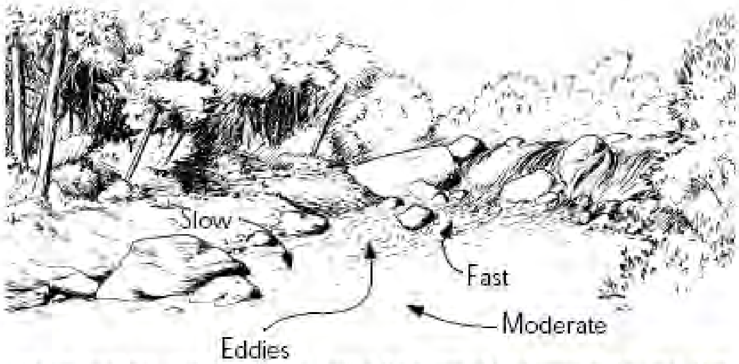
Moderate - non-turbulent flow that is detectable and visible (i.e. floating objects are readily transported downstream); water surface is visibly connected.

Slow - water flow is perceptible, but very sluggish.

Eddies - small areas of circular current motion usually formed in pools immediately downstream from riffle-run areas.

Interstitial - water flow that is perceptible only in the interstitial spaces between substrate particles in riffle-run areas.

Intermittent - no flow is evident anywhere leaving standing pools that are separated by dry areas.



Higher gradient stream showing typical locations of fast, moderate, and slow areas and of eddies..

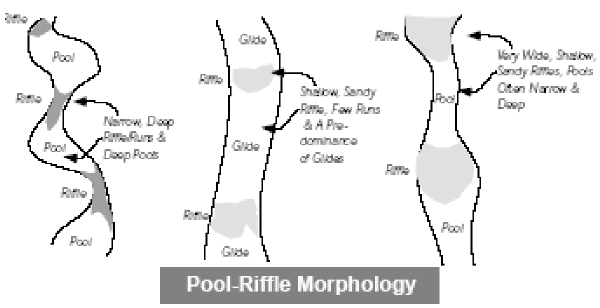


Illustration of three typical pool-riffle morphologies in streams..

4) *Morphology* - Check **Wide** if pools are wider than riffles, **Equal** if pools and riffles are the same width, and **Narrow** if the riffles are wider than the pools (Score 0 to 2). If the morphology varies throughout the site average the types. If the entire stream area (including areas outside of the sampling zone) is pool or riffle, then check riffle = pool.

Although the theoretical maximum score is > 12 the maximum score assigned for the QHEI for the Pool Quality metric is limited to 12 points.

B) Riffle-Run Quality

(score 0 for this metric if no riffles are present)

1)Riffle - select one box that most closely describes the depth characteristics of the best riffle in the zone (Score 0 to 4). The best riffle is selected because we want to identify bottlenecks during harsh periods (*e.g.*, drought). Estimate depth in areas that are clearly riffle, not transitional between a riffle and a run. If the riffle is generally less than 5 cm in depth riffles are considered to have loss their function and the entire riffle metric is scored a 0

2) Run Depth - select one box that most closely describes the depth characteristics of the runs (Score 0 to 4). Estimate depth in areas that are clearly run, not transitional between a pool and a run or a riffle and a run.

2) *Riffle/Run Substrate Stability*—select one box from each that best describes the substrate type and stability of the riffle habitats (Score 0 to 2).

3) *Riffle/Run Embeddedness*—Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material (sand, silt); here in the riffle/runs only. We consider substrates embedded if >50% of surface of the substrates are embedded in fine material—these substrates cannot be easily dislodged. This also includes substrates that are concreted. Boxes are checked for extensiveness (riffle/run area of sampling zone) with embedded substrates: **Extensive** — > 75% of stream area, **Moderate** — 50-75%, **Sparse** — 25-50%, **Low** — < 25%.

The maximum score assigned for the QHEI for the Riffle/Run Quality metric is 8 points.

Metric 6: Map Gradient

Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area.This is done by measuring the stream length between the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the contour interval. If the contour lines are closely "packed" a minimum distance of at least one mile should be used. Some judgement may need to be exercised in certain anomalous areas (e.g. in the vicinity of waterfalls, impounded areas, etc.) and this can be compared to an in-field, visual estimate which is recorded on the back of the habitat sheet.

Scoring for ranges of stream gradient takes into account the varying influence of gradient with stream size, preferably measured as drainage area in square miles or stream width. Gradient classifications (Table V-4-3) were modified from Trautman (p 139, 1981) and scores were assigned, by stream size category, after examining scatterplots of IBI vs. natural log of gradient in feet/mile (see Rankin 1989). Scores are listed in Table V-4-3

The maximum QHEI metric score for Gradient is 10 points.

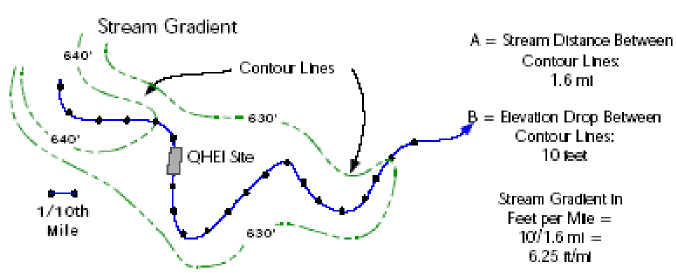


Illustration of methodology for determining stream gradient from topographic maps

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Computing the Total QHEI Score: To compute the total QHEI score, add the components of each metric to obtain the metric scores and then sum the metric scores to obtain the total QHEI score. The QHEI metric scores cannot exceed the Metric Maximum Score indicated below.

QHEI SCORING (Maximum = 100)

QHEI Metric	Metric Component	Component Scoring Range	Metric Max. Score
1) Substrate	a) Type b) Quality	0 to 21 -5 to 3	20
2) Instream Cover	a) Type b) Amount	0 to 10 1 to 11	20
3) Channel Morphology	a) Sinuosity b) Development c) Channelization d) Stability	1 to 4 1 to 7 1 to 6 1 to 3	20
4) Riparian Zone	a) Width b) Quality c) Bank Erosion	0 to 4 0 to 3 1 to 3	10
5a) Pool Quality	a) Max. Depth b) Current c) Morphology	0 to 6 -2 to 4 0 to 2	12
5b) Riffle Quality	a) Depth b) Substr Stab. c) Substr Embd.	0 to 4 0 to 2 -1 to 2	8
6) Gradient		2 to 10	10

Additional Information

Additional information is recorded on the reverse side of the Site Description Sheet (Fig. V-4-6) and is described as follows:

1) *Additional Comments/Pollution Impacts* - Different types of pollution sources (e.g. wastewater treatment plant, feedlot, industrial discharge, nonpoint source
Table V-4-3 - Gradient
Figure V-4-6
inputs) are noted with their proximity (in 0.1 mile increments) to the sampling site; any evidence of litter either instream or on the stream bank is also noted.

2) *Sampling Gear/Distance Sampled* - The type of fish sampling gear used during each pass is specified (See Table V-4-1) and any variation in sampling procedures is noted (e.g., sampler type A specifies sampling along one shoreline of 0.5 km, but due to local restrictions, sampling may be performed on both shorelines to accumulate 0.5 km); the total sampling distance in kilometers for each sampling site for each pass is recorded.

3) *Water Clarity* - The following descriptions can be used as a guide:
a) **Clear** - bottom is clearly visible (if shallow enough) and the water contains no apparent color or staining.
b) **Stained** - usually a brownish (or other) color to the water; the bottom may be visible in shallow areas.
c) **Turbid** - bottom seldom visible at more than a few inches; caused by suspended sediment particles.

The apparent source of stained (e.g. tannic acid, leaf decay, etc.) and turbid (e.g. runoff [clay/silt], algae/diatoms, sewage, etc.) may be specified under additional comments.

4) *Water Stage* - This is the general water level of the stream during each pass; suggested descriptors are: a) flood, b) high, c) elevated, d) normal, e) low, and f) interstitial. (Note: sampling should not be conducted during flood or high flows).

5) *Canopy* - This is the percentage of the sampling site that is not covered or shaded by woody bank vegetation. In wide streams and rivers this determination should be made along both sides of the river or stream (i.e., the percent of the sampling path that is open).

6) *Gradient* - Check the box that best describes the gradient at the site. This will be used to check the accuracy of gradients taken from topographic maps.

7) *Stream Measurements* (optional) - Certain stream measurements make be recorded to allow a level II Rosgen stream classification to be performed. The

techniques are covered in Rosgen (1995).

8) *Major Suspected Sources of Impacts* - If there are any obvious sources of pollution that may be responsible for impacts to a stream, it is identified here. These categories are taken from the USEPA 305(b) guidance.

9) *Stream Maps and Diagram* - Stream maps for each site can be very important. The act of drawing a map usually helps to identify habitat types scored with the QHEI. It can also help later samples identify sampling sites and determine whether changes have occurred.

The level of detail of the drawings will likely vary with the objective. For example, sites assessed for 401 purposes should have as much detail as possible to help in later decisions of habitat limitations or high potential.

Two or three cross-sections of the stream can provide useful information on the stream bank, stream bottom, stream channel, and floodplain characteristics.

New Cover Metric

We are currently field testing a new cover metric that may replace the existing one in a year or two. The existing scoring methodology measures presence or absence of cover types, and in the total, a measure of cover diversity, but not distinguish among levels of quality in any single type (e.g., woody debris). The lines to the right of the cover boxes are for the new procedure.

Each cover type is scored on a scale of 0-3 as follows:

Zero - Cover type absent;

1 - Cover type present in very small amounts or if more common of marginal quality;

2 - Cover type present in moderate amounts, but not of highest quality or in small amounts of highest quality;

3 - Cover type of highest quality in moderate or greater amounts.

Examples of highest quality include very large boulders in deep, fast water, large diameter logs that are stable and not silted, large and well developed rootwads in deep and fast water, or deep, well defined, functional (e.g., not silted) pools.

This data will be analyzed and the old metric may be discontinued in the future.

For more information contact:
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FAX: 614.728.3380
http://chagrin.epa.state.oh.us/

This and other publications are available on the Division of Surface Water Web Site:

Table 1: Classification of stream gradients for Ohio by stream size. Modified from Trautman (p 139, 1981). Scores were derived from plots of IBI versus stream gradient for each stream size category.

Stream Width	Drainage Area (sq mi)	Gradient (feet/mile)						
		Very Low	Low	Low-Moderate	Moderate	Moderate-High	High	Very High[1]
≤ 4.7	< 9.2	0 - 1.0 **2**	1.1 - 5.0 **4**	5.1 - 10.0 **6**	10.1 - 15.0 **8**	15.1 - 20 **10**	20.1 - 30 **10**	30.1 - 40 **8**
4.8 - 9.2	9.2 - 41.6	0 - 1.0 **2**	1.1 - 3.0 **4**	3.1 - 6.0 **6**	6.1 - 12.0 **10**	12.1 - 18 **10**	18.1 - 30 **8**	30.1 - 40 **6**
9.3 - 13.8	41.7 - 103.7	0 - 1.0 **2**	1.1 - 2.5 **4**	2.6 - 5.0 **6**	5.1 - 7.5 **8**	7.6 - 12 **10**	12.1 - 20 **8**	20.1 - 30 **6**
13.9 - 30.6	103.8 - 622.9	0 - 1.0 **4**	1.1 - 2.0 **6**	2.1 - 4.0 **8**	4.1 - 6.0 **10**	6.1 - 10 **10**	10.1 - 15 **8**	15.1 - 25 **6**
> 30.6	> 622.9		0 - 0.5 **6**	0.6 - 1.0 **8**	1.1 - 2.5 **10**	2.6 - 4.0 **10**	4.1 - 9 **10**	> 9 **8**

[1]Any site with a gradient greater than the upper bound of the "very high" gradient classification is assigned a score of 4.

QHEI Pool/Riffle Development Metric

Excellent Pool/Riffle Development:

Pools - > 1 m Deep
Glides - Only Transitional Habitats
Runs - > 0.5 m Deep
Riffles - Deep, Large Substrates
Morphology - All Habitats Easily Definable, Riffles Narrow and Deep, Pools Wide with Deep and Shallow Sections

Good Pool/Riffle Development:

Pools - > 0.7 m Deep
Glides - Mostly Transitional Habitats
Runs - Deep, but < 0.5 m
Riffles - Some Deep Areas, Large Substrates (At Least Large Gravels)
Morphology - All Habitats Fairly Well Definable, Riffles Typically Narrower Than Most Pools

Fair Pool/Riffle Development:

Pools - Show Some Depth Variation
Glides - Common
Runs - Typically Absent
Riffles - Poorly Defined, Shallow
Morphology - Habitat Types Not As Distinct, Glides Typically Difficult to Separate From Pools and Riffles

Poor Pool/Riffle Development:

Pools - Shallow if Present
Glides - Predominant
Runs - Absent
Riffles - Absent, Or if Present Unstable and Shallow With Fine Substrates
Morphology - Mostly Glide Characteristics, Riffles Ephemeral if Present

Midwest Biodiversity Institute **MBI**

Qualitative Habitat Evaluation Index Field Sheet QHEI Score: ____

River Code: ___________ *RM:* _______ *Stream:* ____________________
Date: _______________ *Location:* ____________________
Scorers Full Name: _______________ *Affiliation:* ____________________

1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present

TYPE	POOL RIFFLE		POOL RIFFLE	SUBSTRATE ORIGIN Check ONE (OR 2 & AVERAGE)		SUBSTRATE QUALITY Check ONE (OR 2 & AVERAGE)
☐☐-BLDR /SLBS[10]	___ ___	☐☐-GRAVEL [7]	___ ___			
☐☐-BOULDER [9]	___ ___	☐☐-SAND [6]	___ ___	☐ -LIMESTONE [1]	SILT:	☐ - SILT HEAVY [-2]
☐☐-COBBLE [8]	___ ___	☐☐-BEDROCK[5]	___ ___	☐ -TILLS [1]		☐ -SILT MODERATE [-1]
☐☐-HARDPAN [4]	___ ___	☐☐-DETRITUS[3]	___ ___	☐ -WETLANDS[0]		☐ -SILT NORMAL [0]
☐☐-MUCK [2]	___ ___	☐☐-ARTIFICIAL[0]	___ ___	☐ -HARDPAN [0]		☐ -SILT FREE [1]
☐☐-SILT [2]	___ ___	NOTE: Ignore Sludge Originating From Point Sources		☐ -SANDSTONE [0]	EMBEDDEDNESS:	☐ -EXTENSIVE [-2]
				☐ -RIP/RAP [0]		☐ -MODERATE [-1]
NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >)		☐-4 or More [2]		☐ -LACUSTRINE [0]		☐ -NORMAL [0]
		☐-3 or Less [0]		☐ -SHALE [-1]		☐ -NONE [1]
				☐ -COAL FINES [-2]		

Substrate ____ Max 20

COMMENTS____________________

2] INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)
(Structure) **TYPE:** Score All That Occur

___UNDERCUT BANKS [1]	___POOLS> 70 cm [2]	___OXBOWS, BACKWATERS [1]
___OVERHANGING VEGETATION [1]	___ROOTWADS [1]	___AQUATIC MACROPHYTES [1]
___SHALLOWS (IN SLOW WATER) [1]	___BOULDERS [1]	___LOGS OR WOODY DEBRIS [1]
___ROOTMATS [1]	COMMENTS:____________	

AMOUNT: (Check ONLY One or check 2 and AVERAGE)
☐ - EXTENSIVE > 75% [11]
☐ - MODERATE 25-75% [7]
☐ - SPARSE 5-25% [3]
☐ - NEARLY ABSENT < 5%[1]

Cover ____ Max 20

3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS/OTHER	
☐ - HIGH [4]	☐ - EXCELLENT [7]	☐ - NONE [6]	☐ - HIGH [3]	☐ - SNAGGING	☐ - IMPOUND.
☐ - MODERATE [3]	☐ - GOOD [5]	☐ - RECOVERED [4]	☐ - MODERATE [2]	☐ - RELOCATION	☐ - ISLANDS
☐ - LOW [2]	☐ - FAIR [3]	☐ - RECOVERING [3]	☐ - LOW [1]	☐ - CANOPY REMOVAL	☐ - LEVEED
☐ - NONE [1]	☐ - POOR [1]	☐ - RECENT OR NO RECOVERY [1]		☐ - DREDGING	☐ - BANK SHAPING
				☐ - ONE SIDE CHANNEL MODIFICATIONS	

Channel ____ Max 20

COMMENTS:____________________

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) River Right Looking Downstream

RIPARIAN WIDTH L R (Per Bank)	FLOOD PLAIN QUALITY (*PAST 100 Meter RIPARIAN*) L R (Most Predominant Per Bank)	L R	BANK EROSION L R (Per Bank)
☐☐- WIDE > 50m [4]	☐☐-FOREST, SWAMP [3]	☐☐-CONSERVATION TILLAGE [1]	☐☐-NONE/LITTLE [3]
☐☐- MODERATE 10-50m [3]	☐☐-SHRUB OR OLD FIELD [2]	☐☐-URBAN OR INDUSTRIAL [0]	☐☐-MODERATE [2]
☐☐- NARROW 5-10 m [2]	☐☐-RESIDENTIAL,PARK,NEW FIELD [1]	☐☐-OPEN PASTURE,ROWCROP [0]	☐☐-HEAVY/SEVERE[1]
☐☐- VERY NARROW <5 m[1]	☐☐-FENCED PASTURE [1]	☐☐-MINING/CONSTRUCTION [0]	
☐☐- NONE [0]			

Riparian ____ Max 10

COMMENTS:

5.]POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH (Check 1 ONLY!)	MORPHOLOGY (Check 1 or 2 & AVERAGE)	CURRENT VELOCITY [POOLS & RIFFLES!] (Check All That Apply)	
☐- >1m [6]	☐-POOL WIDTH > RIFFLE WIDTH [2]	☐-EDDIES[1]	☐-TORRENTIAL[-1]
☐- 0.7-1m [4]	☐-POOL WIDTH = RIFFLE WIDTH [1]	☐-FAST[1]	☐-INTERSTITIAL[-1]
☐- 0.4-0.7m [2]	☐-POOL WIDTH < RIFFLE W. [0]	☐-MODERATE [1]	☐-INTERMITTENT[-2]
☐- 0.2- 0.4 m [1]		☐-SLOW [1]	☐-VERY FAST[1]
☐- < 0.2m [POOL=0]	COMMENTS:____________		

Pool/ Current ____ Max 12

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
☐-*Best Areas >10 cm [2]	☐- MAX > 50 [2]	☐-STABLE (e.g.,Cobble, Boulder) [2]	☐- NONE [2]
☐- Best Areas 5-10 cm[1]	☐- MAX < 50[1]	☐-MOD. STABLE (e.g.,Large Gravel) [1]	☐- LOW [1]
☐- Best Areas < 5 cm [RIFFLE=0]		☐-UNSTABLE (Fine Gravel,Sand) [0]	☐- MODERATE [0]
			☐- EXTENSIVE [-1]

Riffle/Run ____ Max 8

COMMENTS:____________________ ☐- NO RIFFLE [Metric=0]

6] GRADIENT (ft/mi): _______ DRAINAGE AREA (sq.mi.) :_______ %POOL: ____ %GLIDE: ____ %RIFFLE: ____ %RUN: ____

Gradient ____ Max 10

*Best areas must be large enough to support a population of riffle-obligate species

06/24/01

Figure 19. MBI Qualitative habitat evaluation index (QHEI) field sheet.

APPENDIX 3. INDEX OF BIOTIC INTEGRITY

3.1. METRICS

Metric	Definition	*Kept*	*Eliminated*		
		Final IBI metrics	**Limited Range**	**Limited Responsiveness**	**Redundancy**
Ind	Total number of individuals captured			X	
Ind-X	Total number of individuals excluding exotics			X	
Ind-H	Total number of individuals excluding hybrids			X	
Ind-T	Total number of individuals excluding tolerant individuals	X			
Tot Kg	Total biomass of all individuals (kg/ind)			X	
Tot kg/Ind	Average biomass per individual (kg/ind)			X	
DELTs	Number of individuals with a deformity, erosion, lesion, and/or tumor			X	
Prop DELTs	Proportion of all individuals with a deformity, erosion, lesion, and/or tumor			X	
#SimpLiths	Number of Simple Lithophillic individuals				X
Sp	Total number of species captured including those only classified to genus				X
Unique Sp	Total number of unique species captured excluding those only classified to genus	X			
#X	Number of exotic individuals			X	
Prop #X	Proportion of all individuals that were exotic			X	
X_Sp	Number of exotic species			X	
Prop X_Sp	Proportion of unique species that were exotic	X			
X kg	Total biomass of all exotic individuals (kg/ind)			X	
X kg/Ind	Average biomass per exotic individual (kg/ind)			X	
#H	Number of hybrid individuals			X	
Prop #H	Proportion of all individuals that were hybrids		X		
H_Sp	Number of hybrid species			X	
Prop H_Sp	Proportion of unique species that were hybrid			X	
H kg	Total biomass of all hybrid individuals (kg/ind)			X	
H kg/Ind	Average biomass per hybrid individual (kg/ind)			X	
#T	Number of tolerant individuals				X
Prop #T	Proportion of all individuals that were tolerants	X			
T_Sp	Number of tolerant species			X	
Prop T_Sp	Proportion of unique species that were tolerant				X
T kg	Total biomass of all tolerant individuals (kg/ind)			X	
T kg/Ind	Average biomass per tolerant individual (kg/ind)			X	
#Int	Number of intolerant individuals				X
Prop #Int	Proportion of all individuals that were intolerants	X			
Int_Sp	Number of intolerant species				X
Prop Int_Sp	Proportion of unique species that were intolerant				X
Int kg	Total biomass of all intolerant individuals (kg/ind)				X
Int kg/Ind	Average biomass per intolerant individual (kg/ind)			X	
#R Suck	Number of round-bodied sucker individuals				X
Prop #R Suck	Proportion of all individuals that were round-bodied suckers	X			
R Suck_Sp	Number of round-bodied sucker species			X	
Prop R Suck_Sp	Proportion of unique species that were round-bodied suckers			X	
R Suck kg	Total biomass of all round-bodied sucker individuals (kg/ind)				X
RS kg/Ind	Average biomass per round-bodied sucker individual (kg/ind)			X	
#DB Suck	Number of deep-bodied sucker individuals			X	
Prop #DB Suck	Proportion of all individuals that were deep-bodied suckers				X
DB Suck_Sp	Number of deep-bodied sucker species				X

Prop DB Suck_Sp	Proportion of unique species that were deep-bodied suckers	X			
DB Suck kg	Total biomass of all deep-bodied sucker individuals (kg/ind)			X	
DBS kg/Ind	Average biomass per deep-bodied sucker individual (kg/ind)			X	
#Cent	Number of centrarchid individuals				X
Prop #Cent	Proportion of all individuals that were centrarchids			X	
Cent's	Number of centrarchid species				X
Prop Cent_Sp	Proportion of unique species that were centrarchid			X	
Cent kg	Total biomass of all centrarchid individuals (kg/ind)			X	
Cent kg/Ind	Average biomass per centrarchid individual (kg/ind)			X	
#GR	Number of great river individuals			X	
Prop #GR	Proportion of all individuals that were great river individuals			X	
Grasp	Number of great river species			X	
Prop Grasp	Proportion of unique species that were great river species			X	
GR kg	Total biomass of all great river individuals (kg/ind)			X	
GR kg/Ind	Average biomass per great river individual (kg/ind)			X	
#Darter	Number of darter individuals	X			
Prop #Darter	Proportion of all individuals that were darters				X
Darter's	Number of darter species			X	
Prop Darter's	Proportion of unique species that were darters				X
Darter kg	Total biomass of all darter individuals (kg/ind)				X
Dart kg/Ind	Average biomass per darter individual (kg/ind)			X	
#Carmi	Number of carnivore individuals				X
Prop #Carmi	Proportion of all individuals that were carnivores	X			
Carnies	Number of carnivore species				X
Prop Carnies	Proportion of unique species that were carnivores				X
Carni kg	Total biomass of all carnivore individuals (kg/ind)				X
Carni kg/Ind	Average biomass per carnivore individual (kg/ind)				X
#Pisc	Number of piscivore individuals			X	
Prop #Pisc	Proportion of all individuals that were piscivores			X	
Pisc_Sp	Number of piscivore species			X	
Prop Pisc_Sp	Proportion of unique species that were piscivores			X	
Pisc kg	Total biomass of all piscivore individuals (kg/ind)			X	
Pisc kg/Ind	Average biomass per piscivore individual (kg/ind)			X	
#C+Pisc	Total number of individuals classified as a carnivore or piscivore				X
Prop #C+Pisc	Proportion of all individuals that were either carnivore or piscivore				X
C+Pisc_Sp	Total number of carnivore and piscivore species				X
Prop C+Pisc_Sp	Proportion of unique species that were either carnivores or piscivores			X	
C+Pisc kg	Total biomass of all carnivore and piscivore individuals (kg/ind)				X
C+Pisc kg/Ind	Average biomass per individual classified as a carnivore or piscivore (kg/ind)			X	
#Detr	Number of detritivore individuals			X	
Prop #Detr	Proportion of all individuals that were detritivores			X	
Detr_Sp	Number of detritivore species			X	
Prop Detr_Sp	Proportion of unique species that were detritivores			X	

Detr kg	Total biomass of all detritivore individuals			X	
Detr kg/Ind	Average biomass per detritivore individual (kg/ind)			X	
#Gen	Number of generalist individuals			X	
Prop #Gen	Proportion of all individuals that were generalists			X	
Gen_Sp	Number of generalist species			X	
Prop Gen_Sp	Proportion of unique species that were generalists	X			
Gen kg	Total biomass of all generalist individuals (kg/ind)			X	
Gen kg/Ind	Average biomass per generalist individual (kg/ind)			X	
#Herb	Number of herbivore individuals				X
Prop #Herb	Proportion of all individuals that were herbivores	X			
Herb_Sp	Number of herbivore species			X	
Prop Herb_Sp	Proportion of unique species that were herbivores				X
Herb kg	Total biomass of all herbivore individuals (kg/ind)				X
Herb kg/Ind	Average biomass per herbivore individual (kg/ind)			X	
#Invert	Number of invertivore individuals			X	
Prop #Invert	Proportion of all individuals that were invertivores			X	
Invert_Sp	Number of invertivore species				X
Prop Invert_Sp	Proportion of unique species that were invertivores			X	
Invert kg	Total biomass of all invertivore individuals (kg/ind)	X			
Invert kg/Ind	Average biomass per invertivore individual (kg/ind)			X	
#Plank	Number of planktivore individuals			X	
Prop #Plank	Proportion of all individuals that were planktivores		X		
Plank_Sp	Number of planktivore species			X	
Prop Plank_Sp	Proportion of unique species that were planktivores		X		
Plank kg	Total biomass of all planktivore individuals (kg/ind)			X	
Plank kg/Ind	Average biomass per planktivore individual (kg/ind)			X	
	TOTALS	**12**	**3**	**68**	**30**

APPENDIX 4. T/E, EXOTIC SPECIES DISTRIBUTION MAPS

4.1. ST.CROIX RIVER

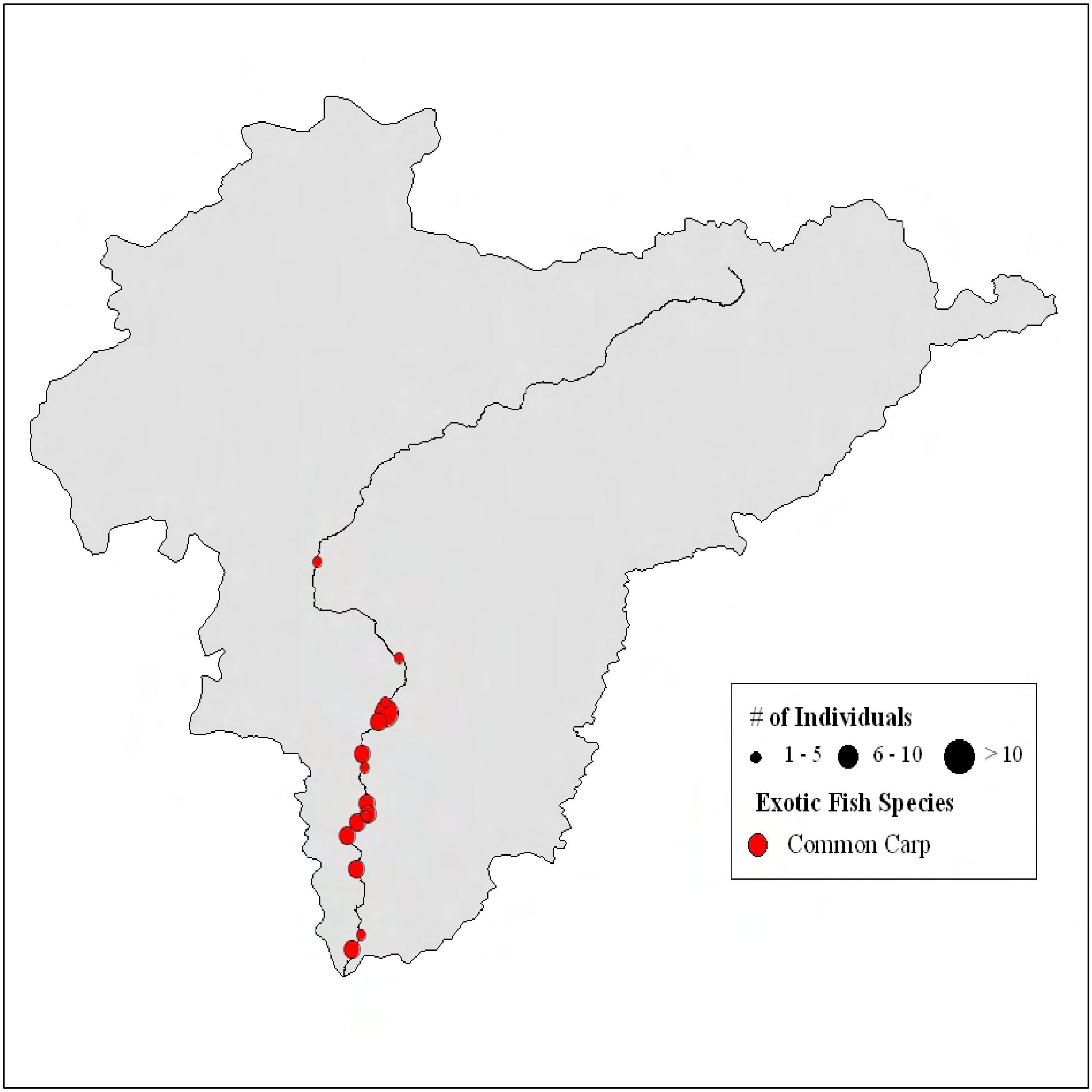

Figure 1. Location and density of St. Croix River exotic fish species.

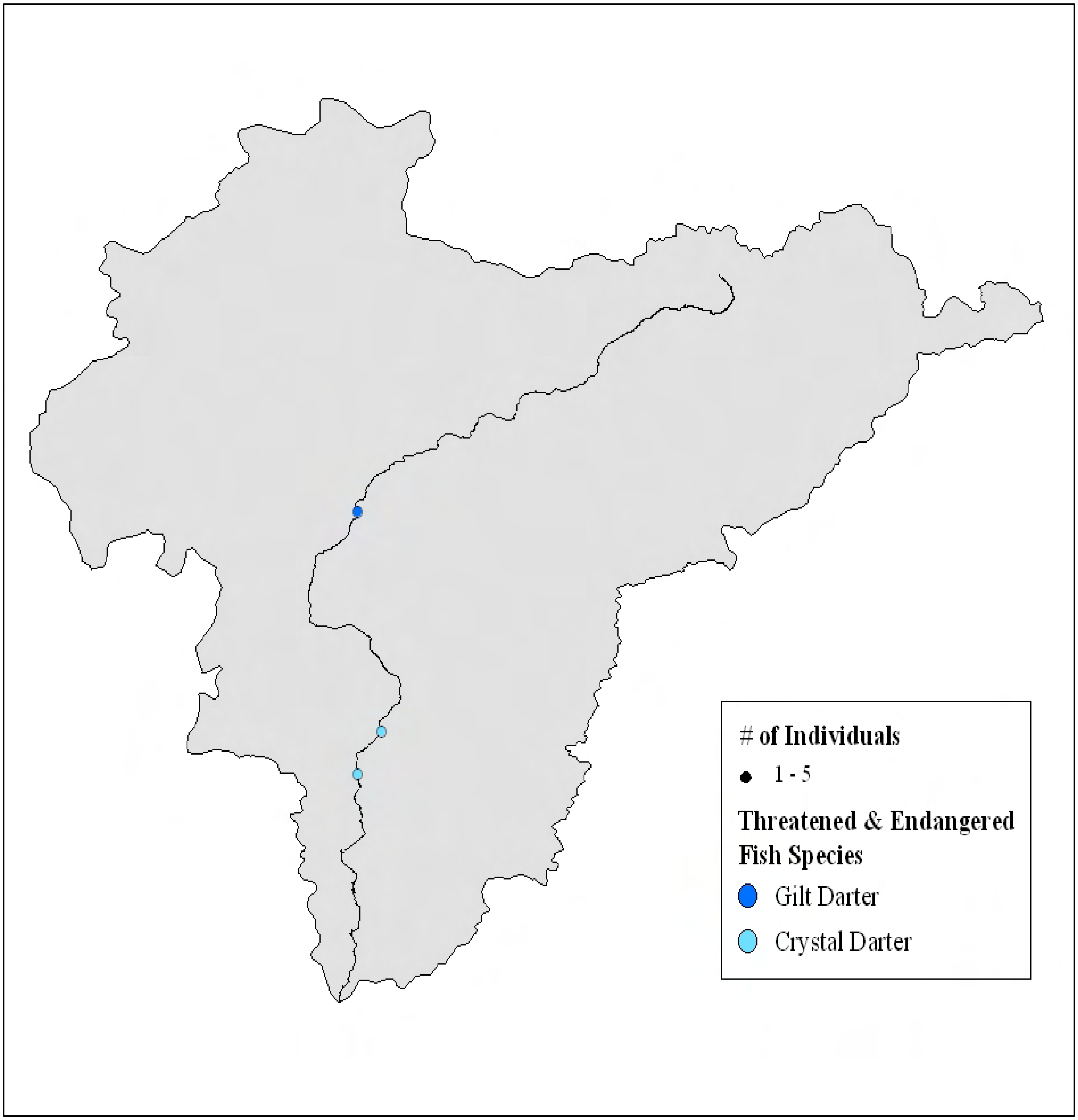

Figure 2. Location and density of St. Croix River threatened and endangered darter species.

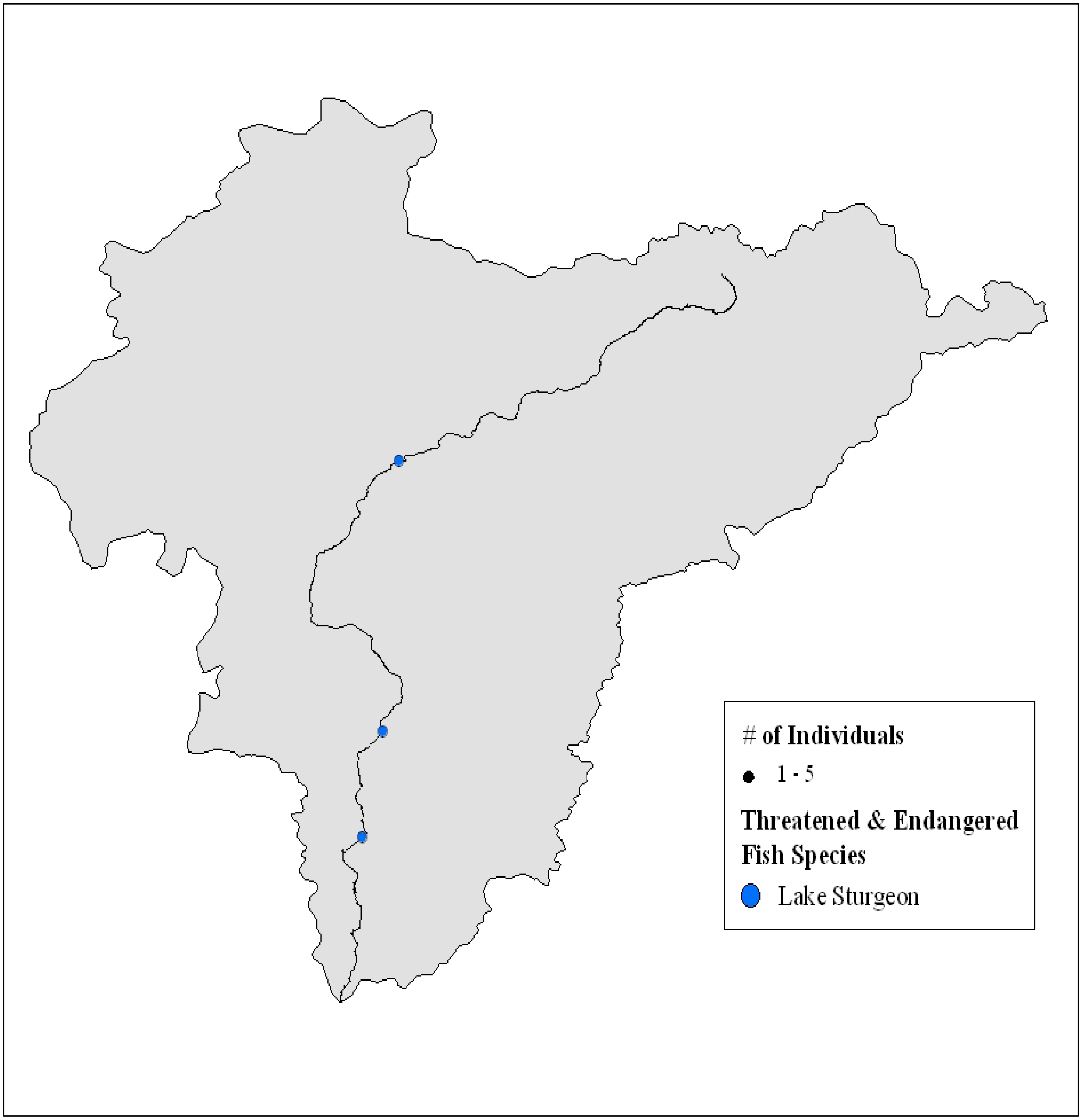

Figure 3. Location and density of St. Croix River sturgeon species.

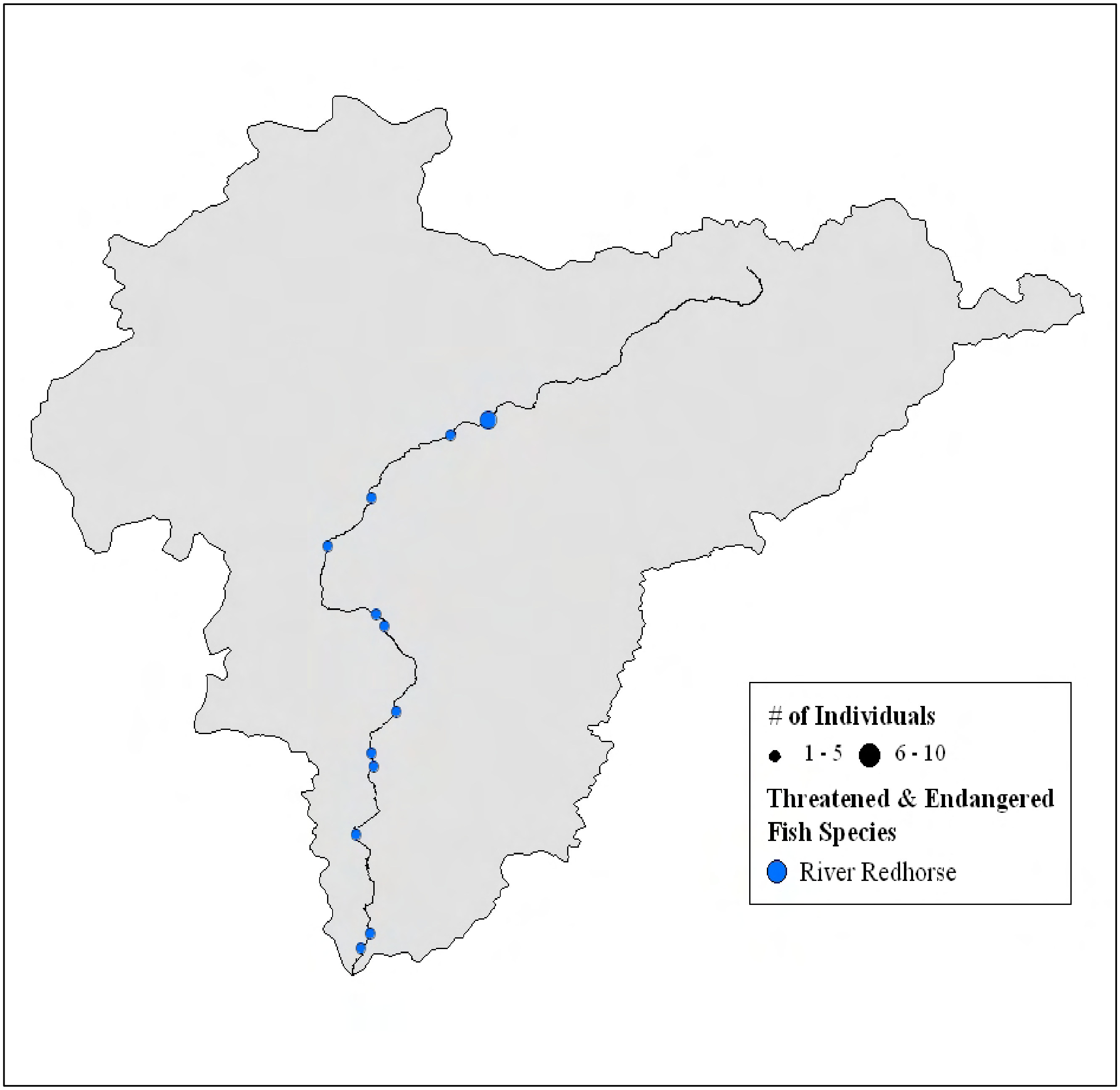

Figure 4. Location and density of St. Croix River redhorse species.

4.2. WABASH RIVER

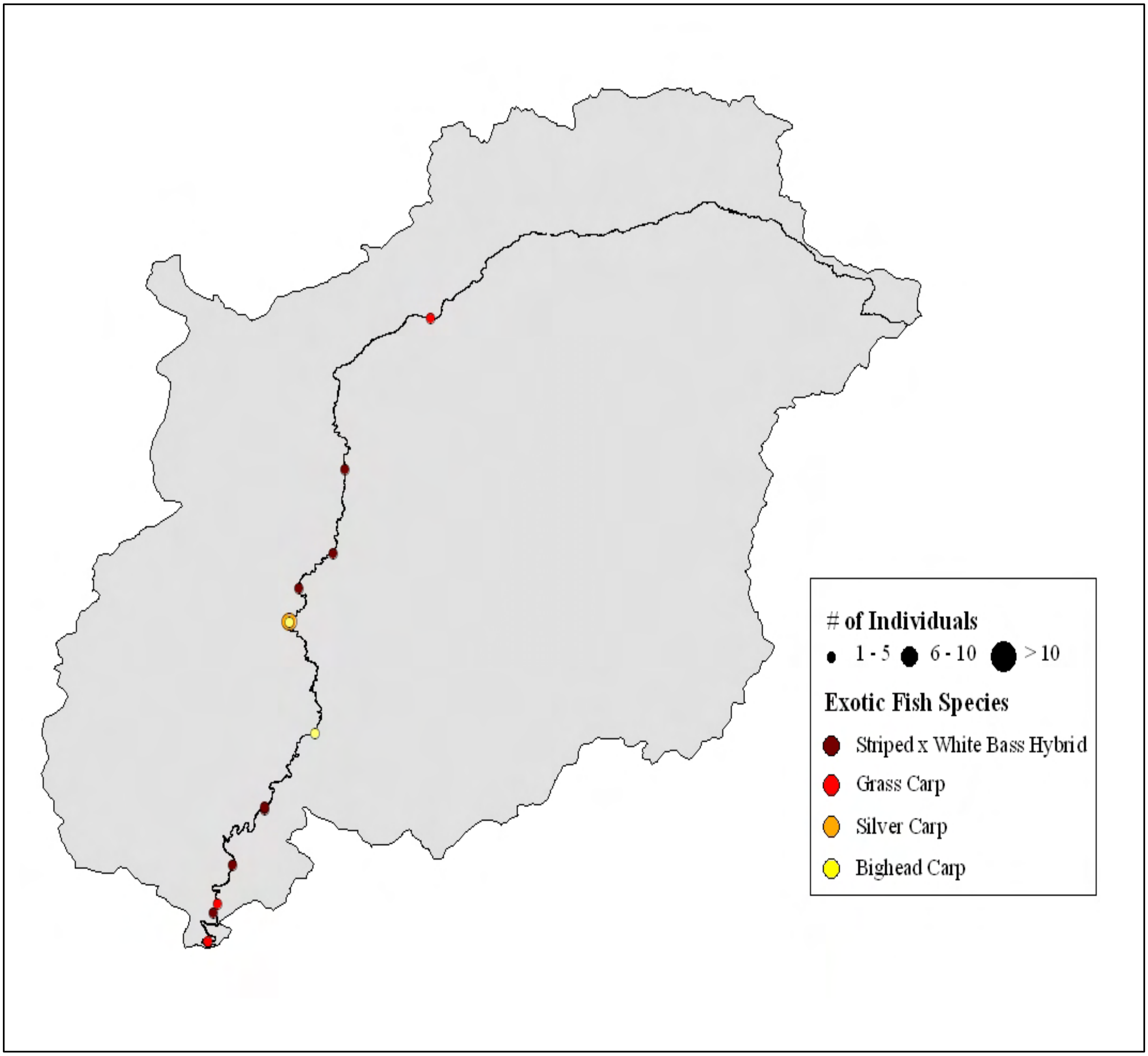

Figure 5. Location and density of Wabash River exotic fish species.

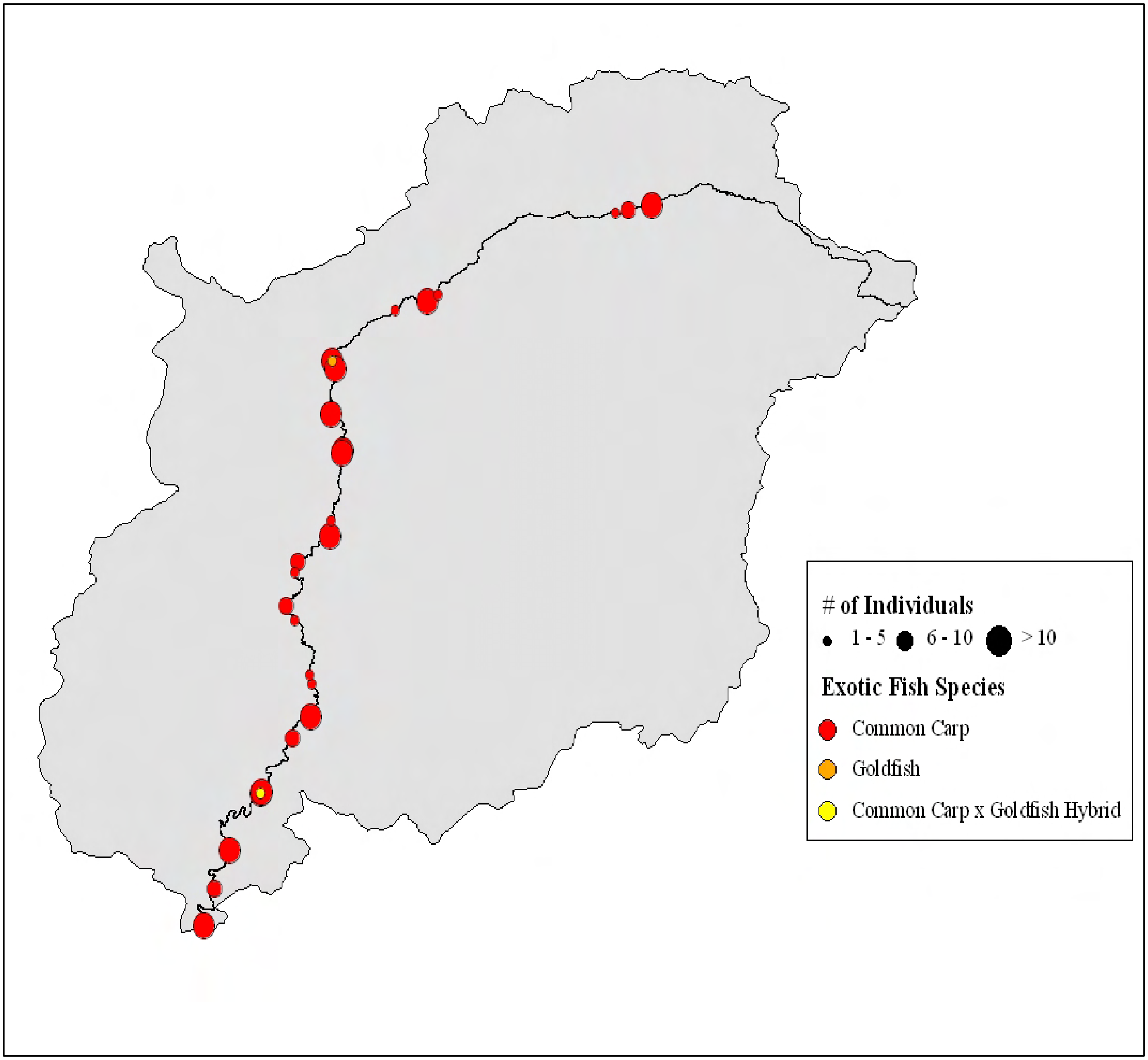

Figure 6. Location and density of Wabash River exotic fish species.

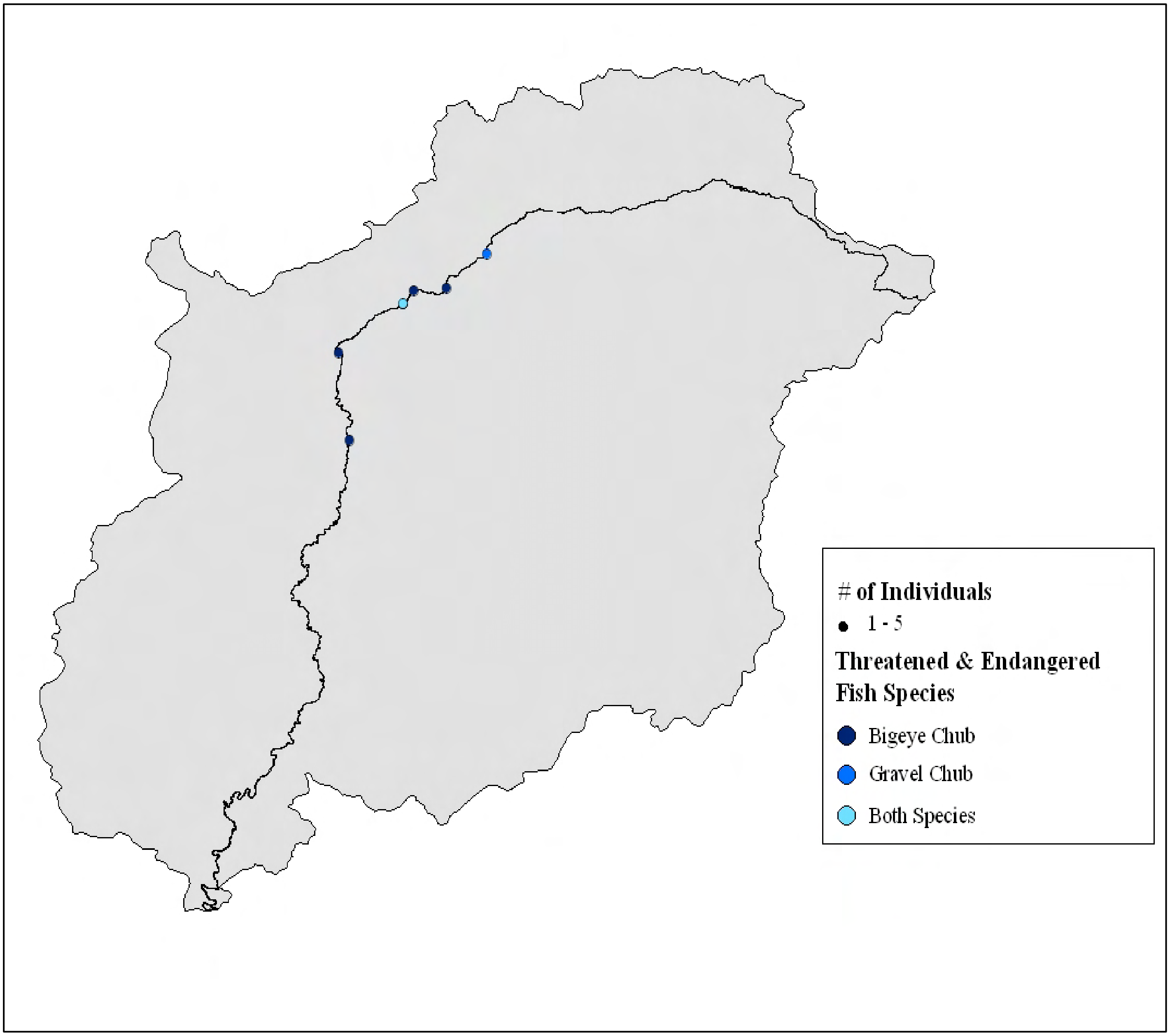

Figure 7. Location and density of Wabash River threatened and endangered fish species.

4.3. WISCONSIN RIVER

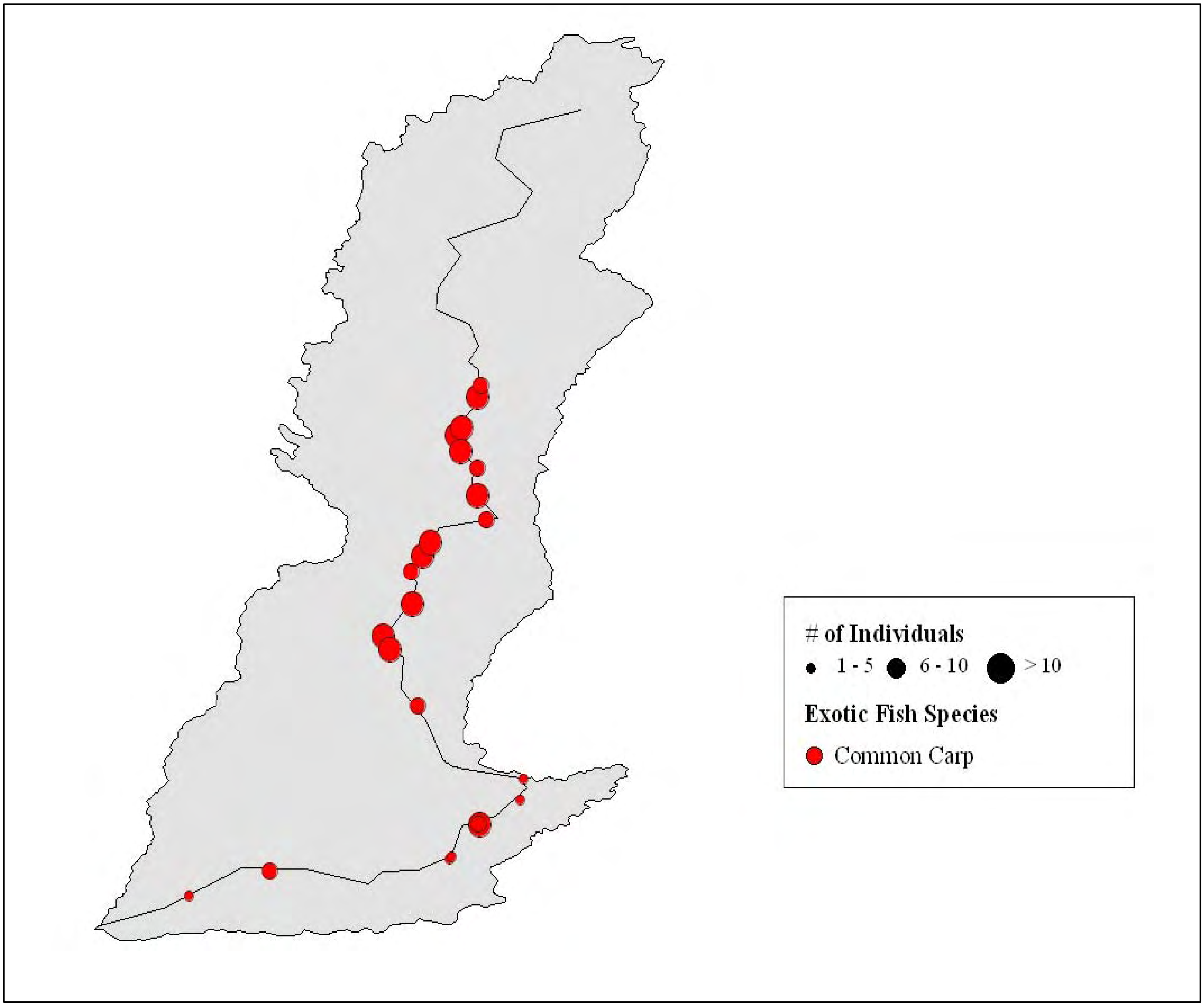

Figure 8. Location and density of Wisconsin River exotic fish species.

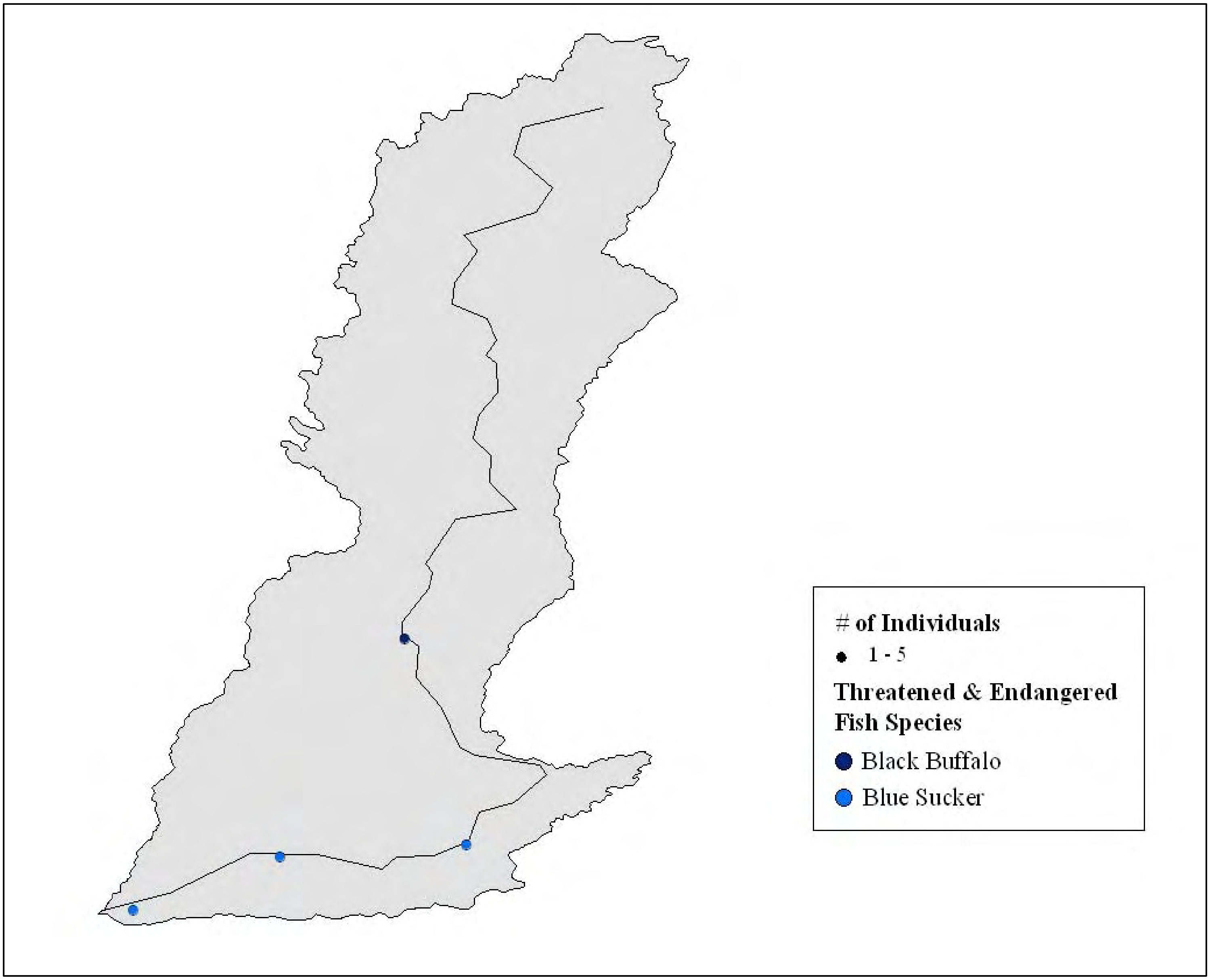

Figure 9. Location and density of Wisconsin River threatened and endangered fish species.

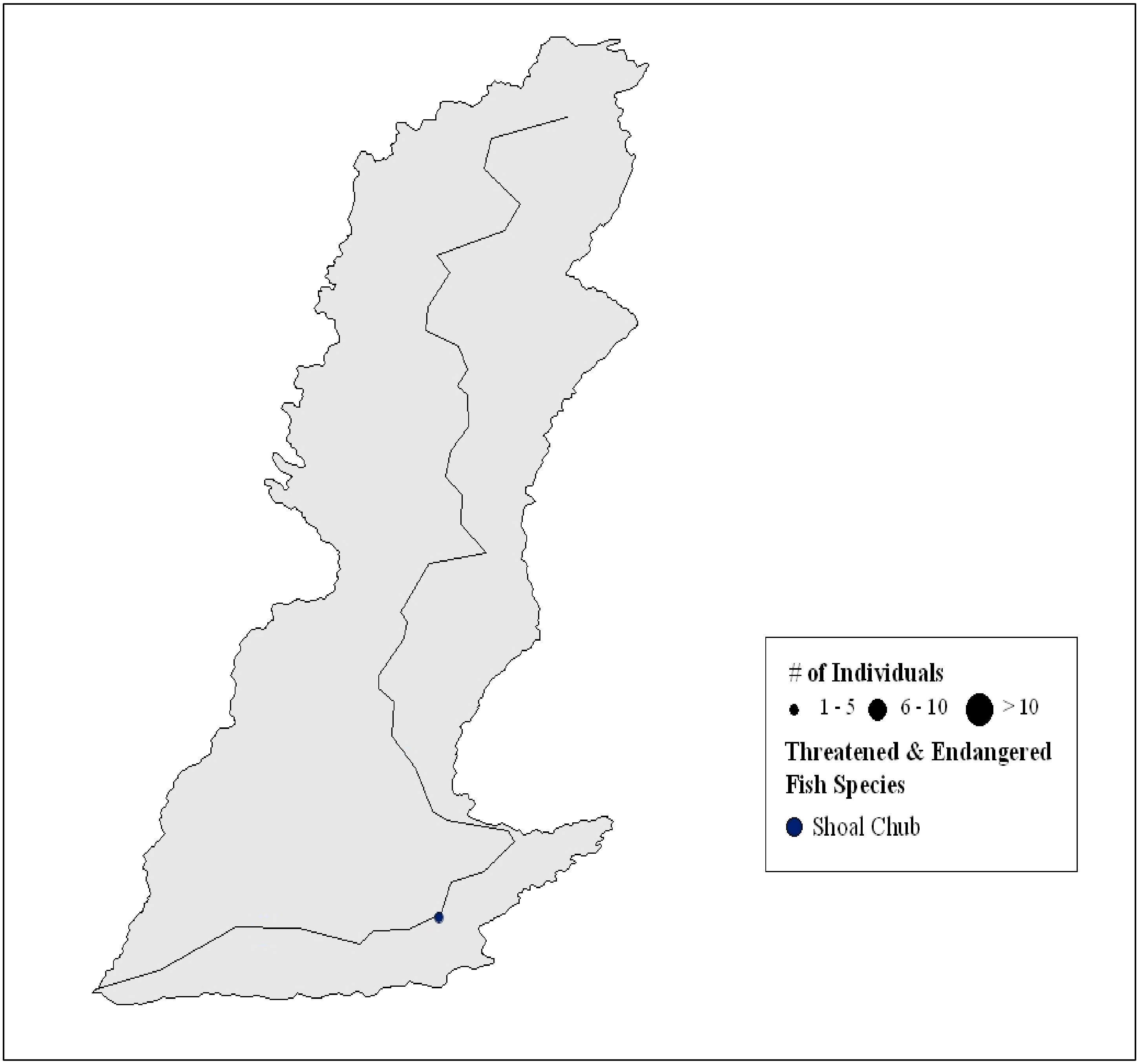

Figure 10. Location and density of Wisconsin River threatened and endangered fish species.

4.4. SCIOTO RIVER

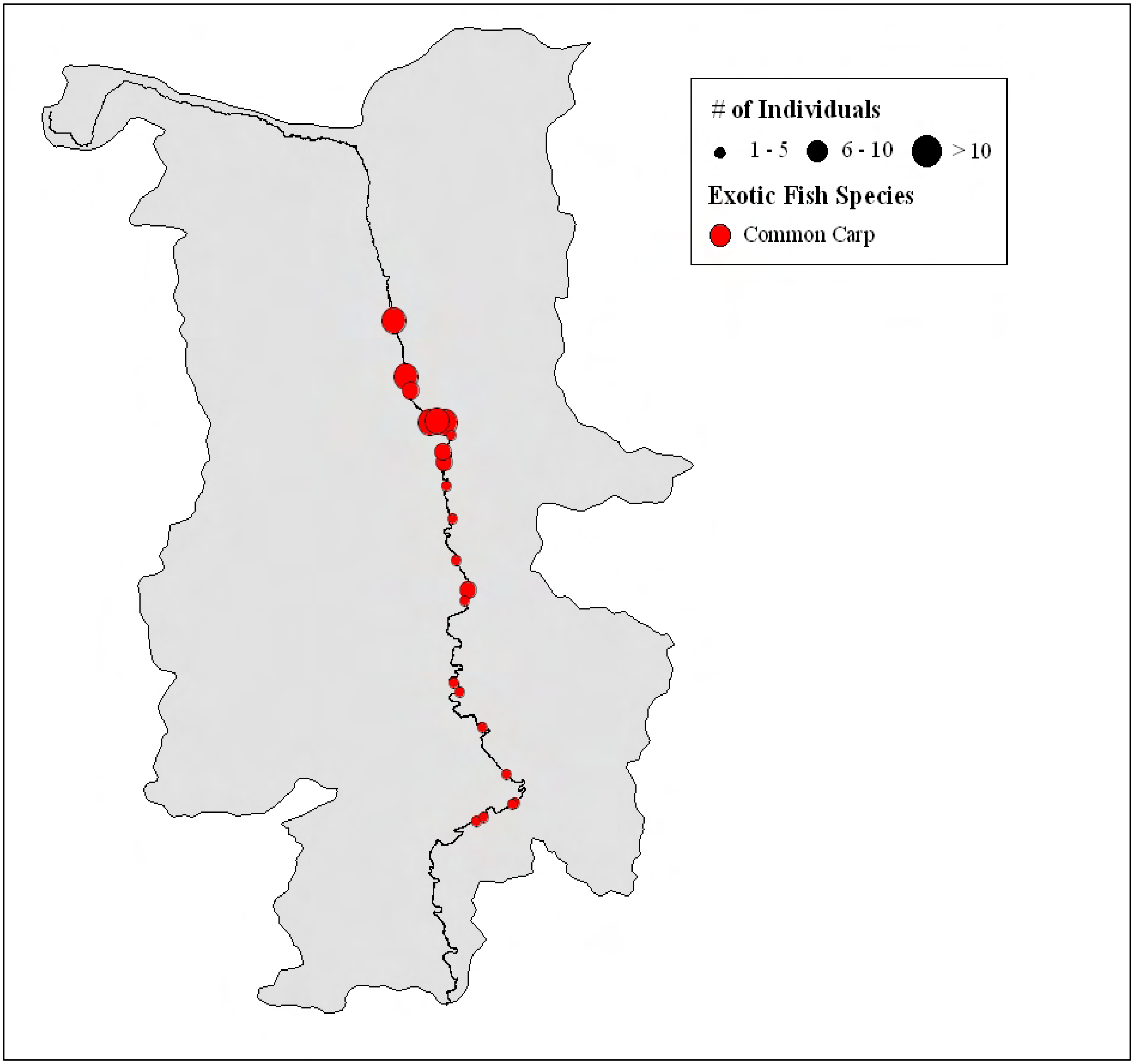

Figure 11. Location and density of Scioto River exotic fish species.

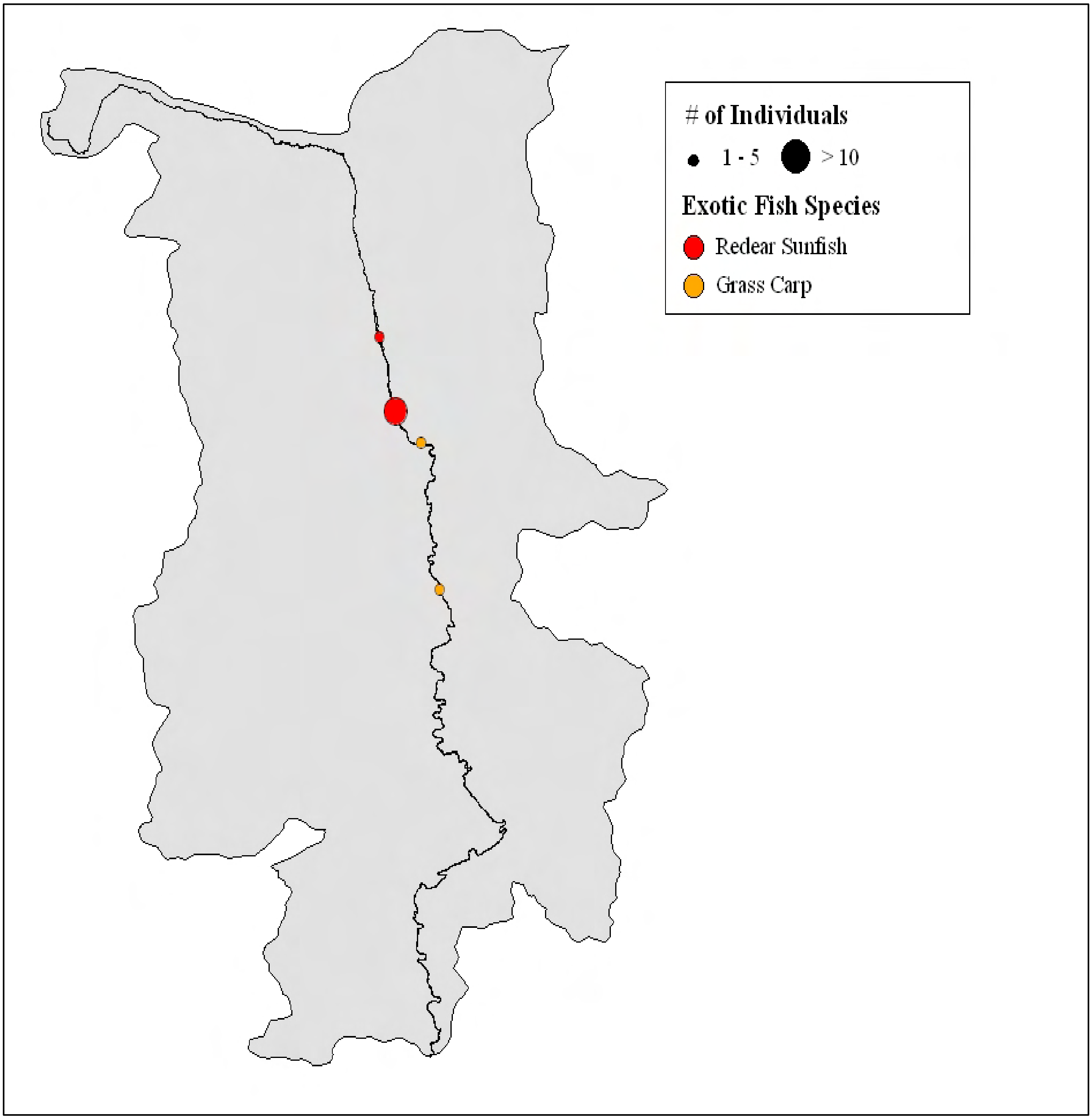

Figure 12. Location and density of Scioto River exotic fish species.

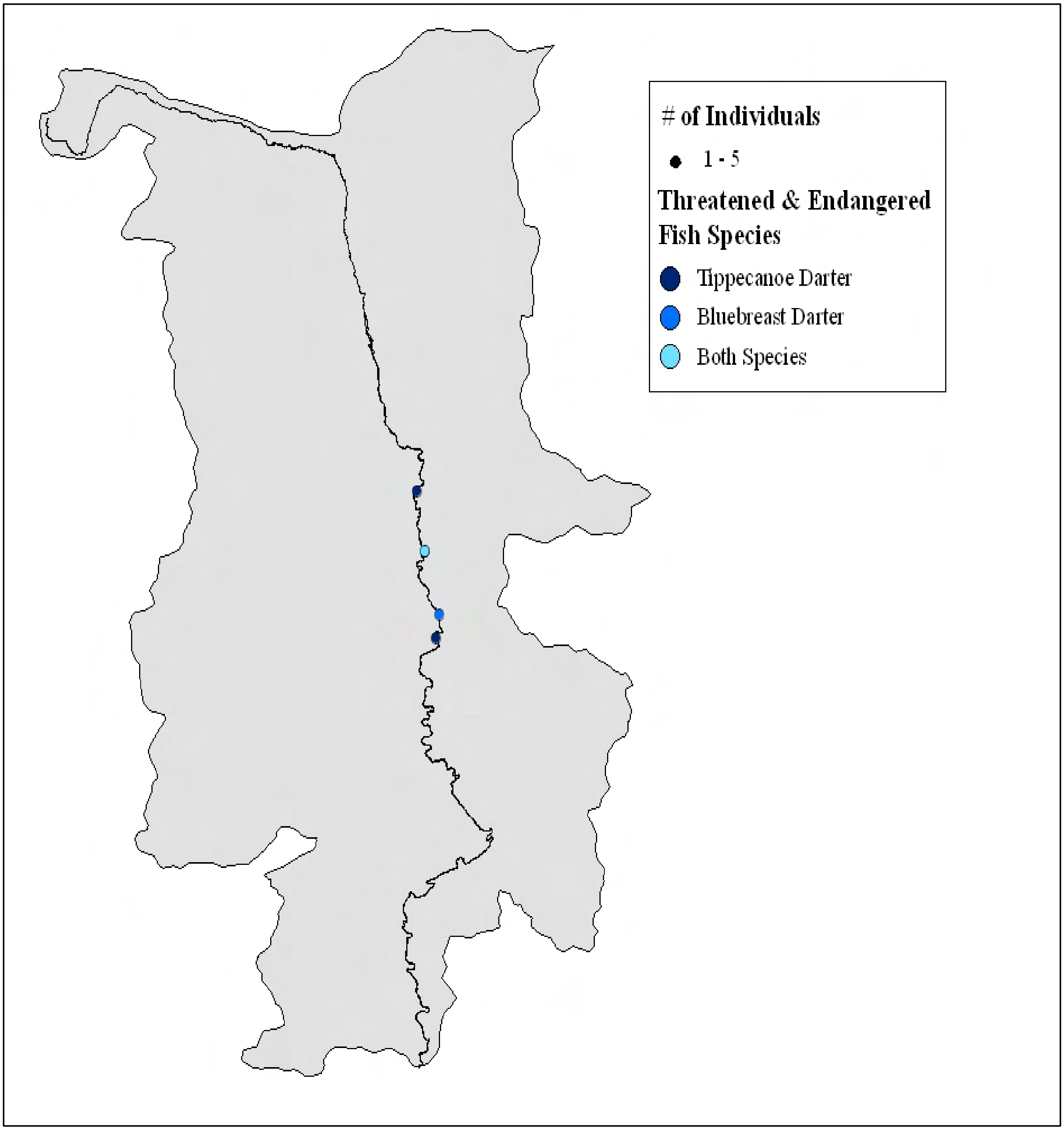

Figure 13. Location and density of Scioto River threatened and endangered fish species.

4.5. MINNESOTA RIVER

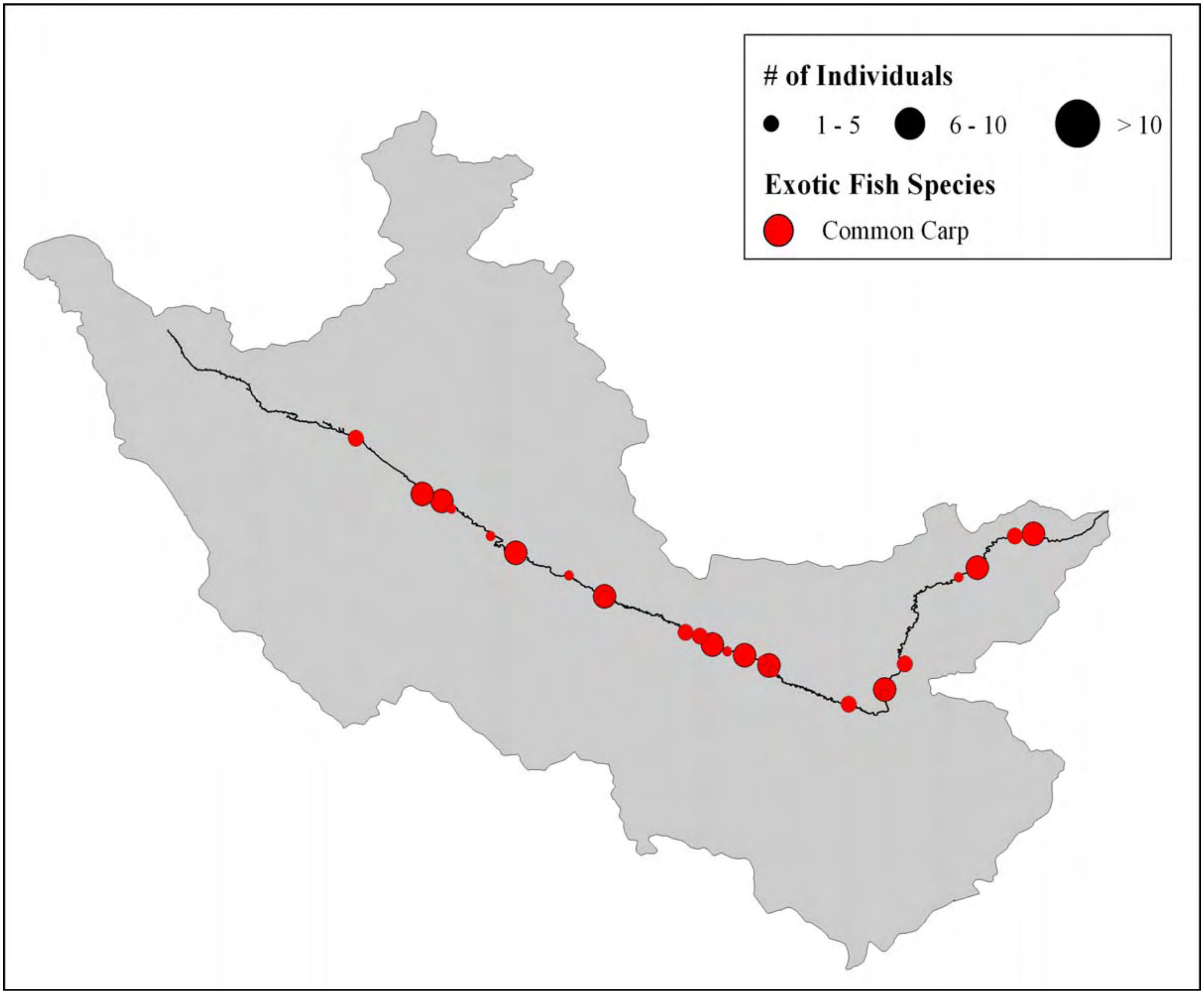

Figure 14. Location and density of Minnesota River exotic fish species.

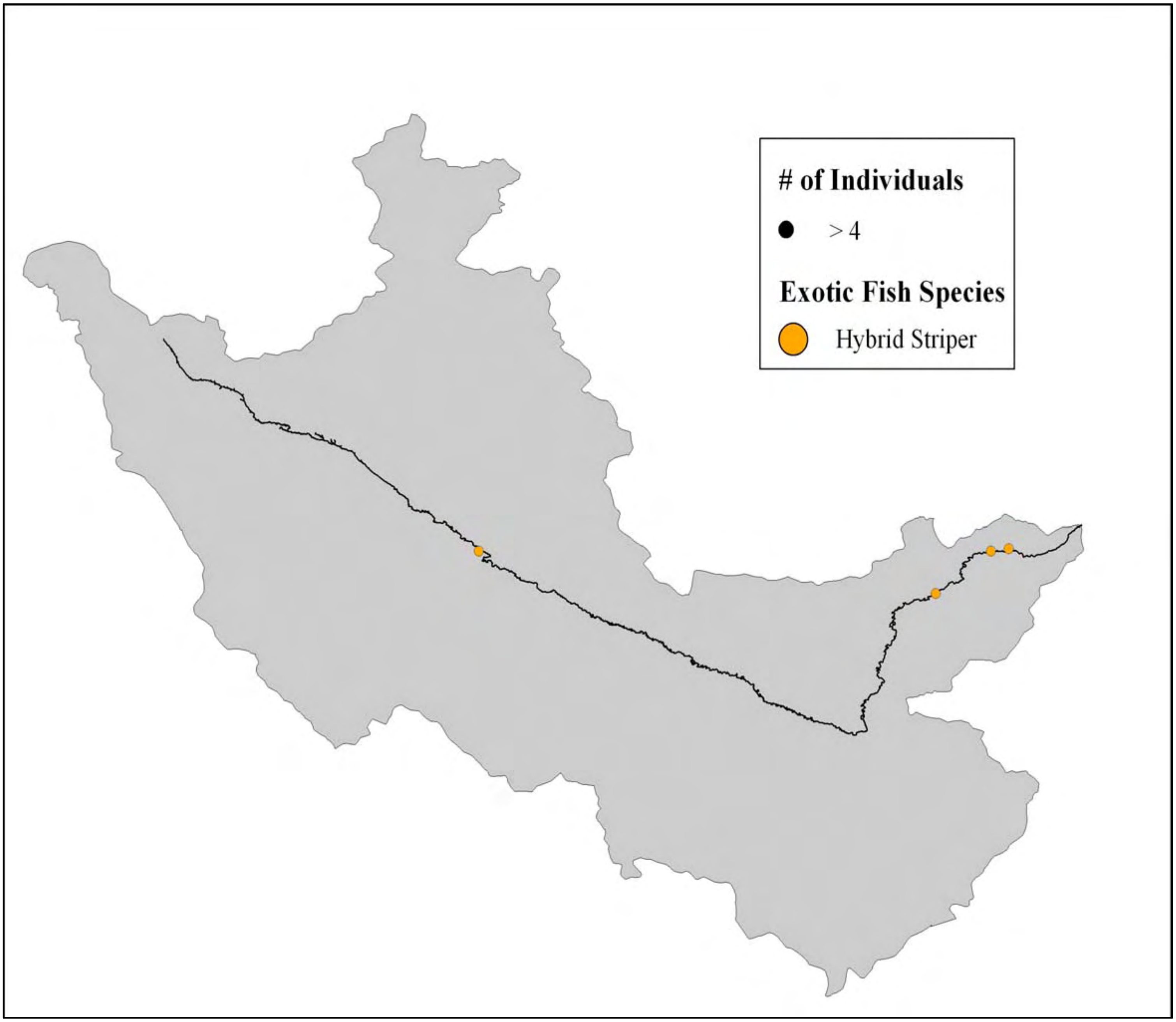

Figure 15. Location and density of Minnesota River exotic fish species.

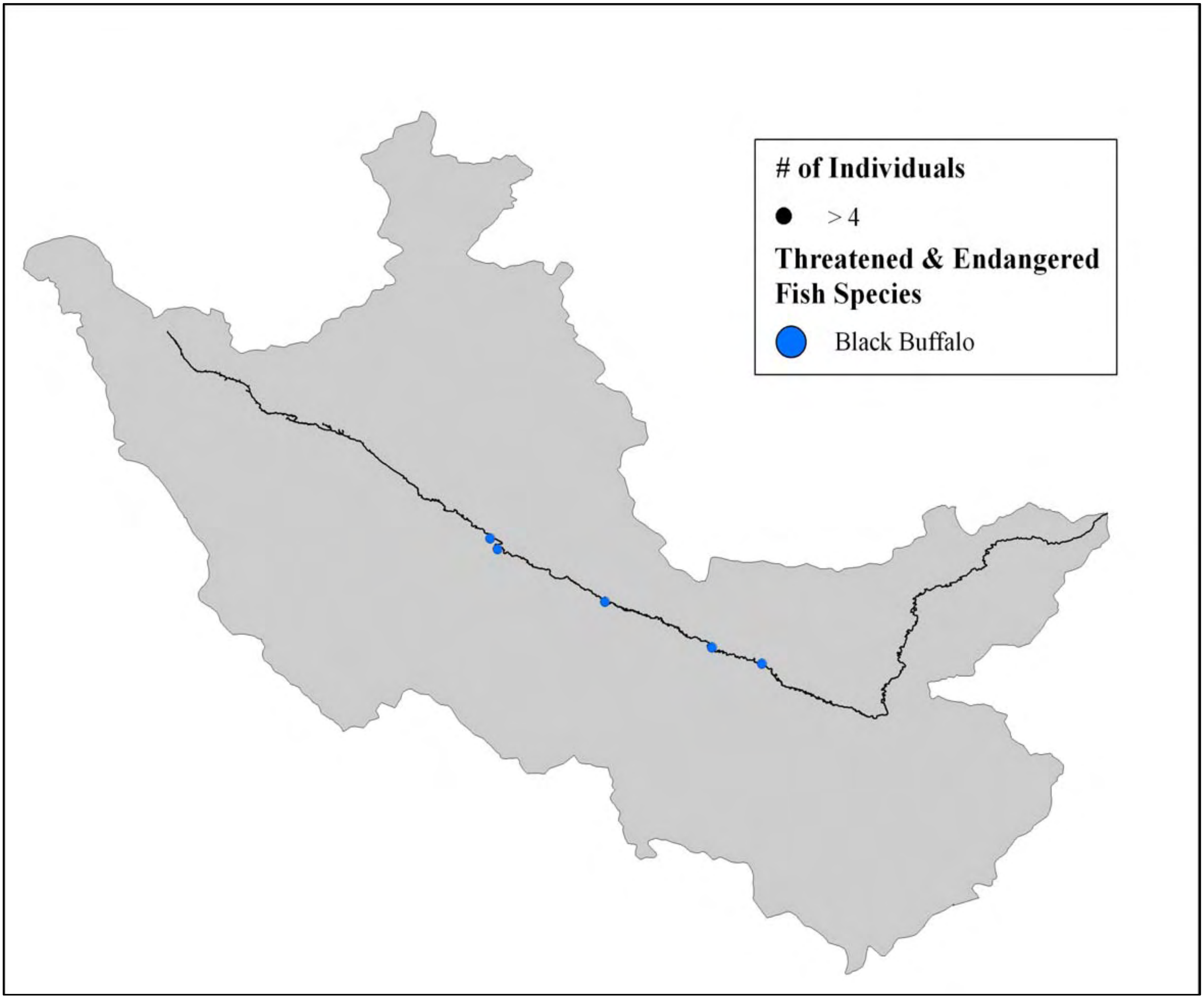

Figure 16. Location and density of Minnesota River threatened and endangered fish species.

4.6. MUSKINGUM RIVER

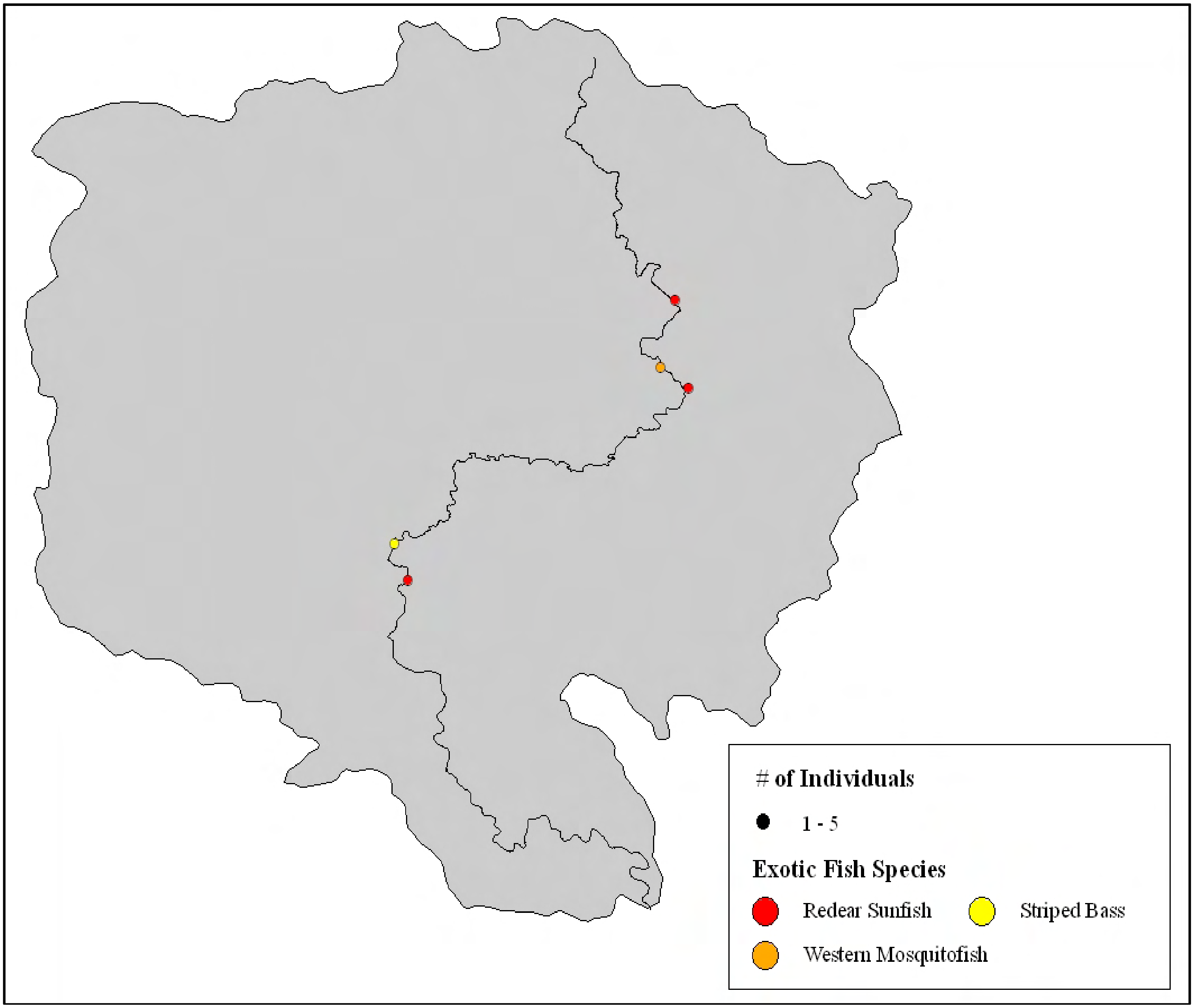

Figure 17. Location and density of Muskingum River exotic fish species.

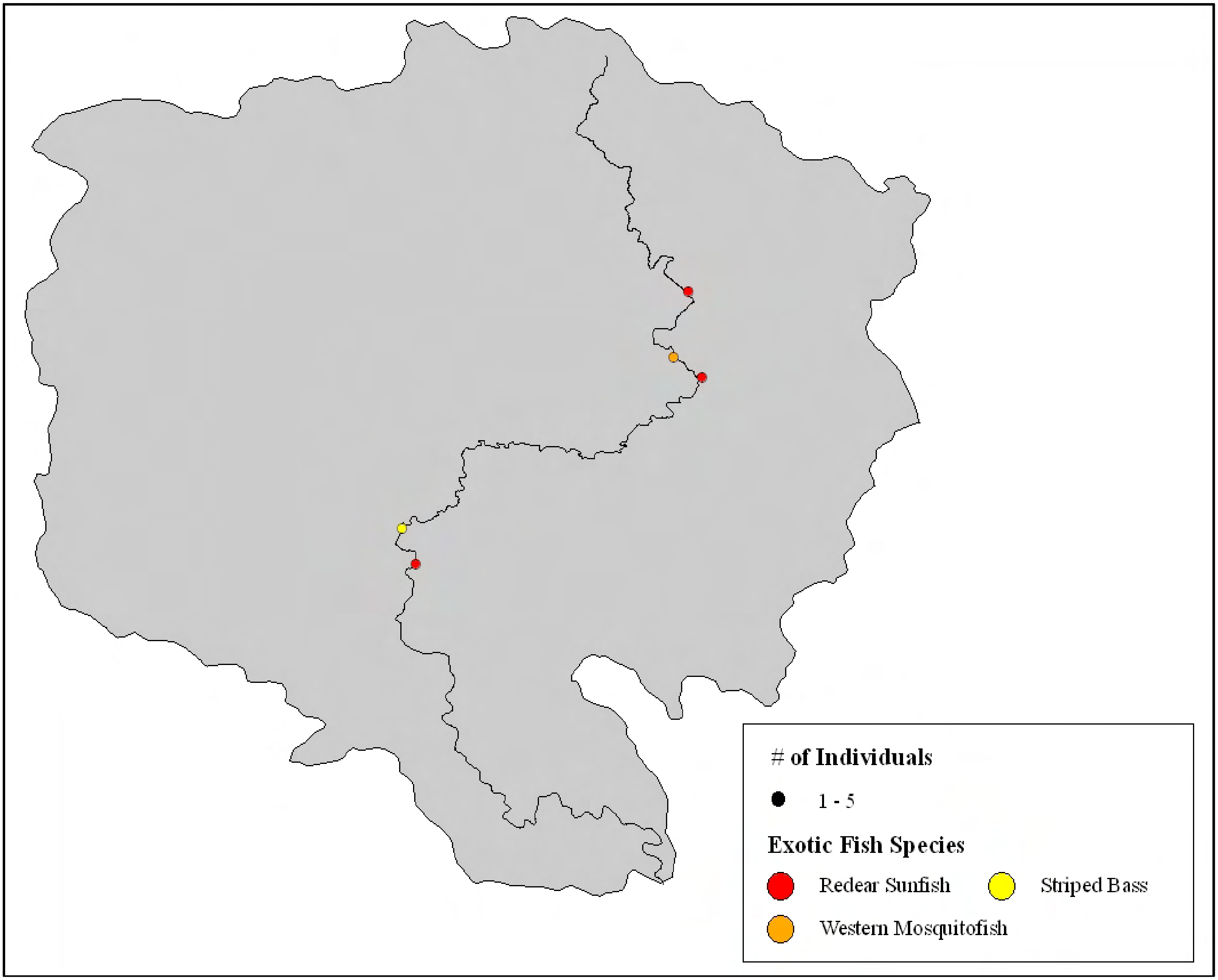

Figure 18. Location and density of Muskingum River exotic fish species.

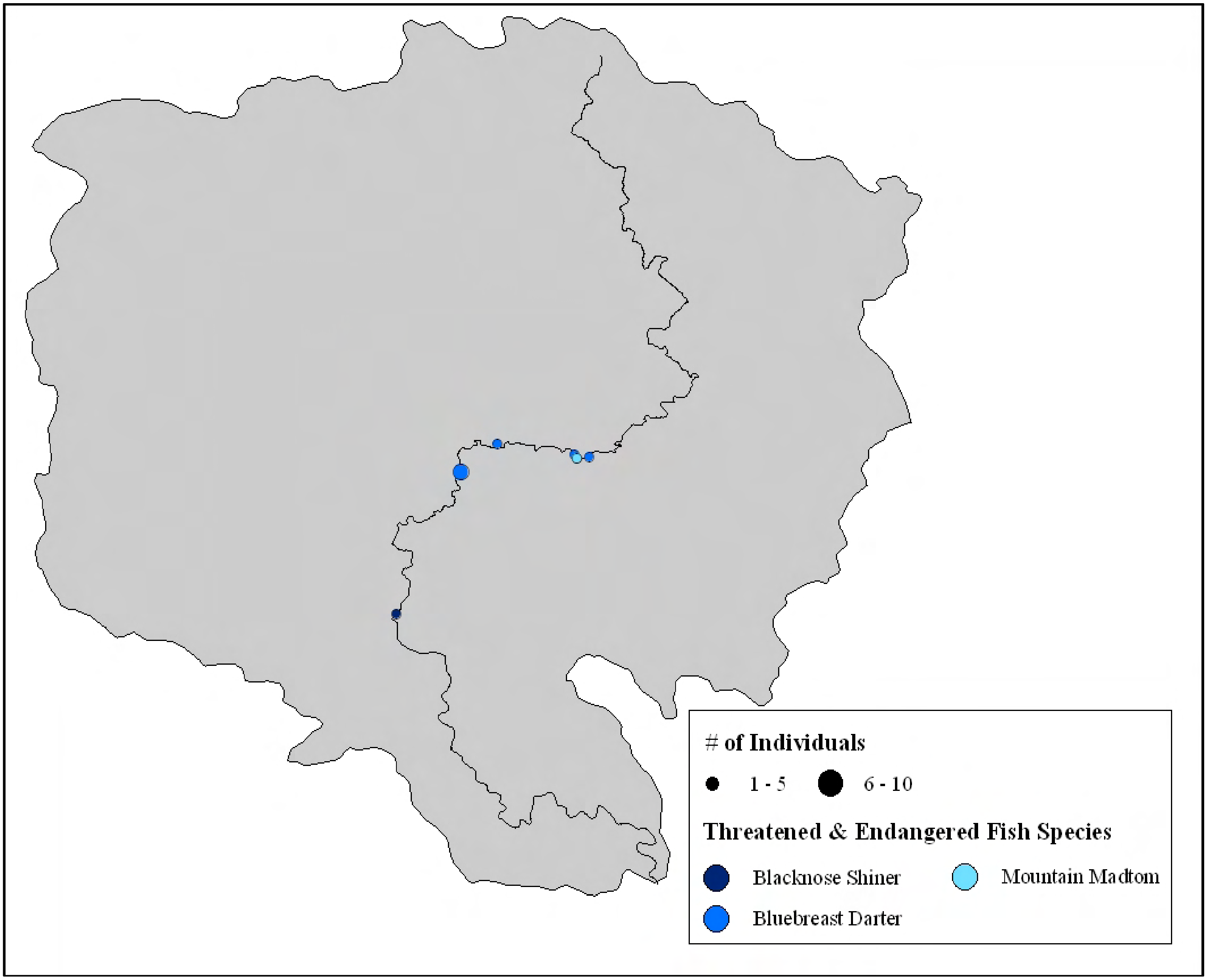

Figure 19. Location and density of Muskingum River threatened and endangered fish species.

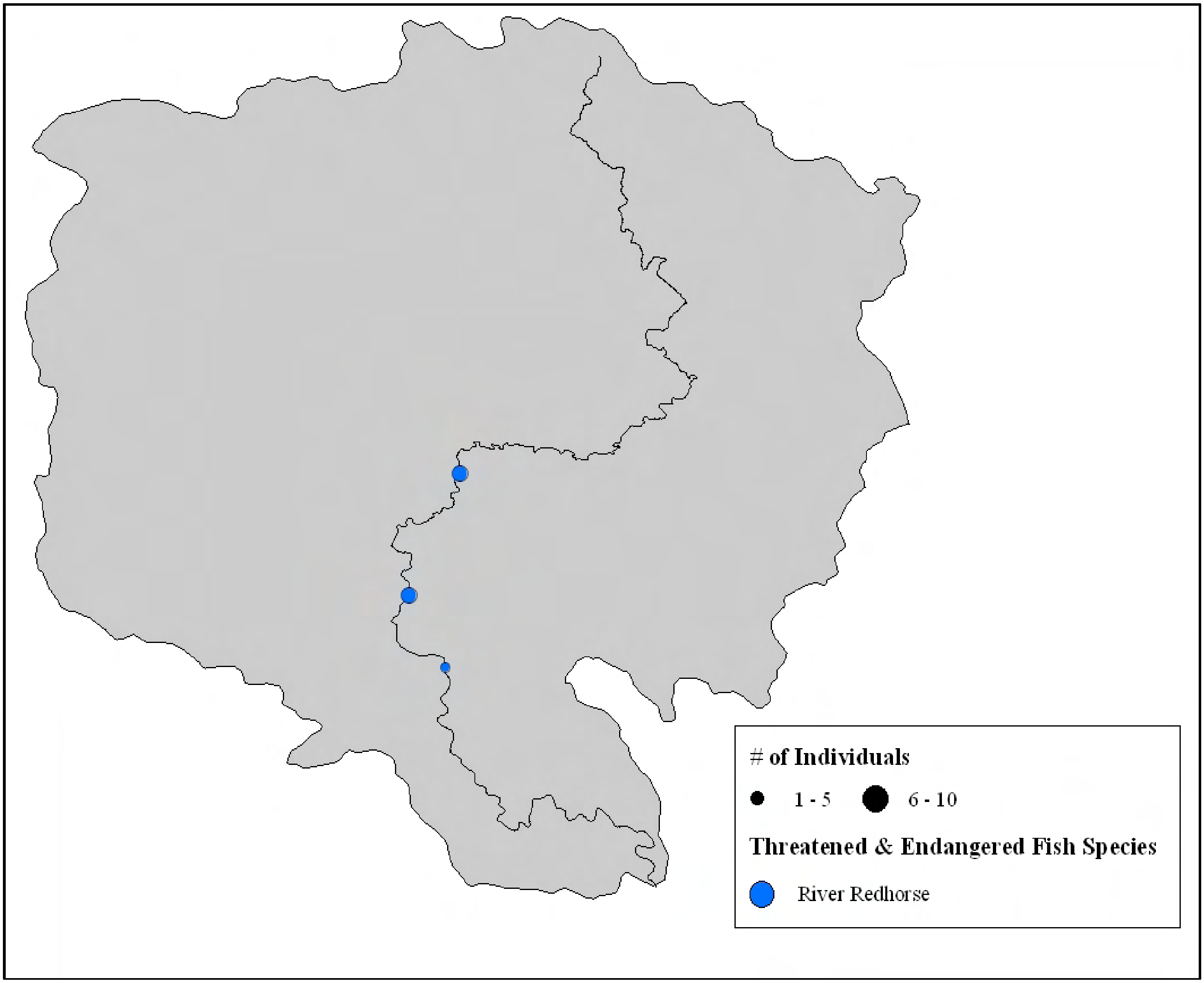

Figure 20. Location and density of Muskingum River threatened and endangered fish species.

4.7. ILLINOIS RIVER

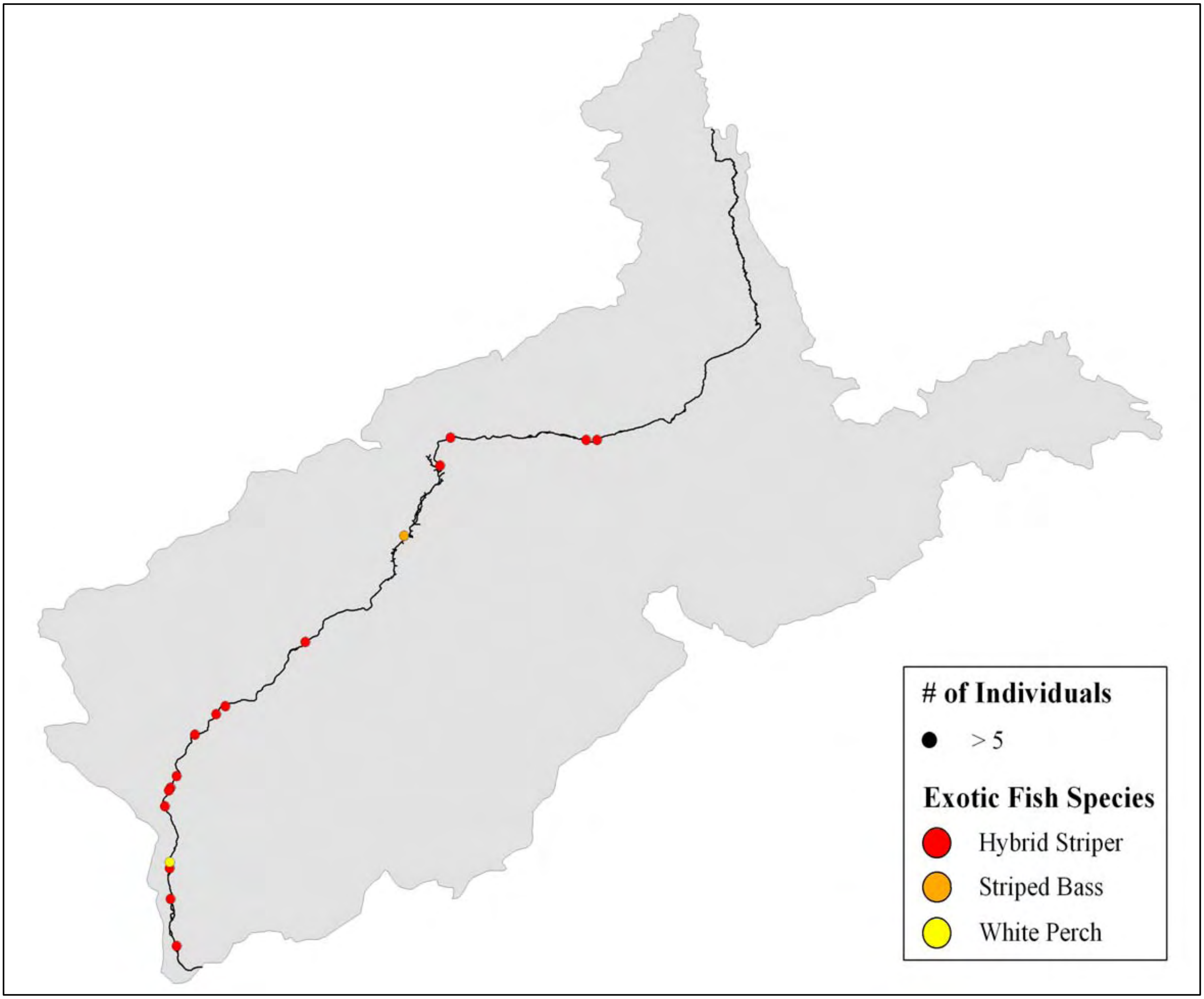

Figure 21. Location and density of Illinois River exotic fish species.

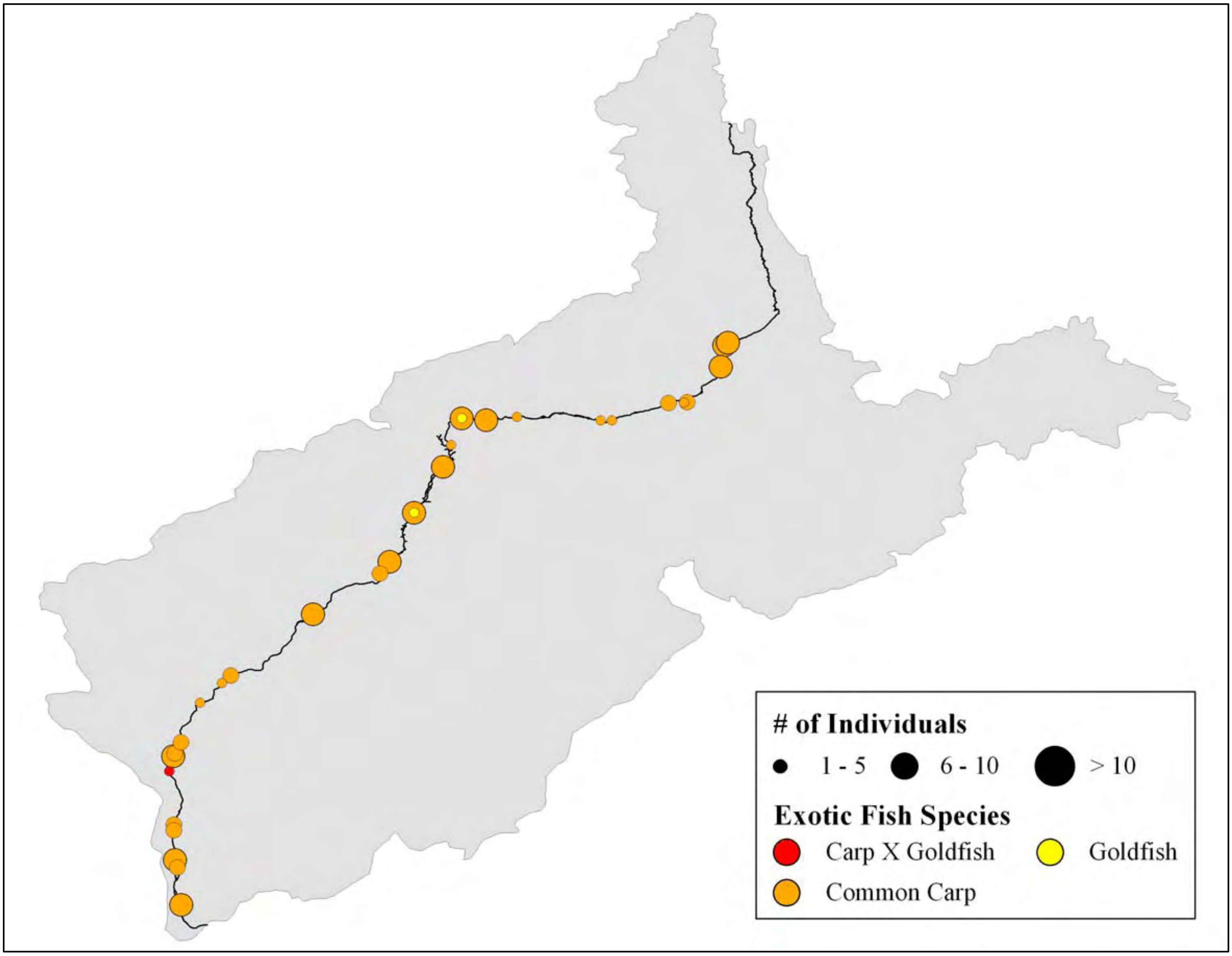

Figure 22. Location and density of Illinois River exotic fish species.

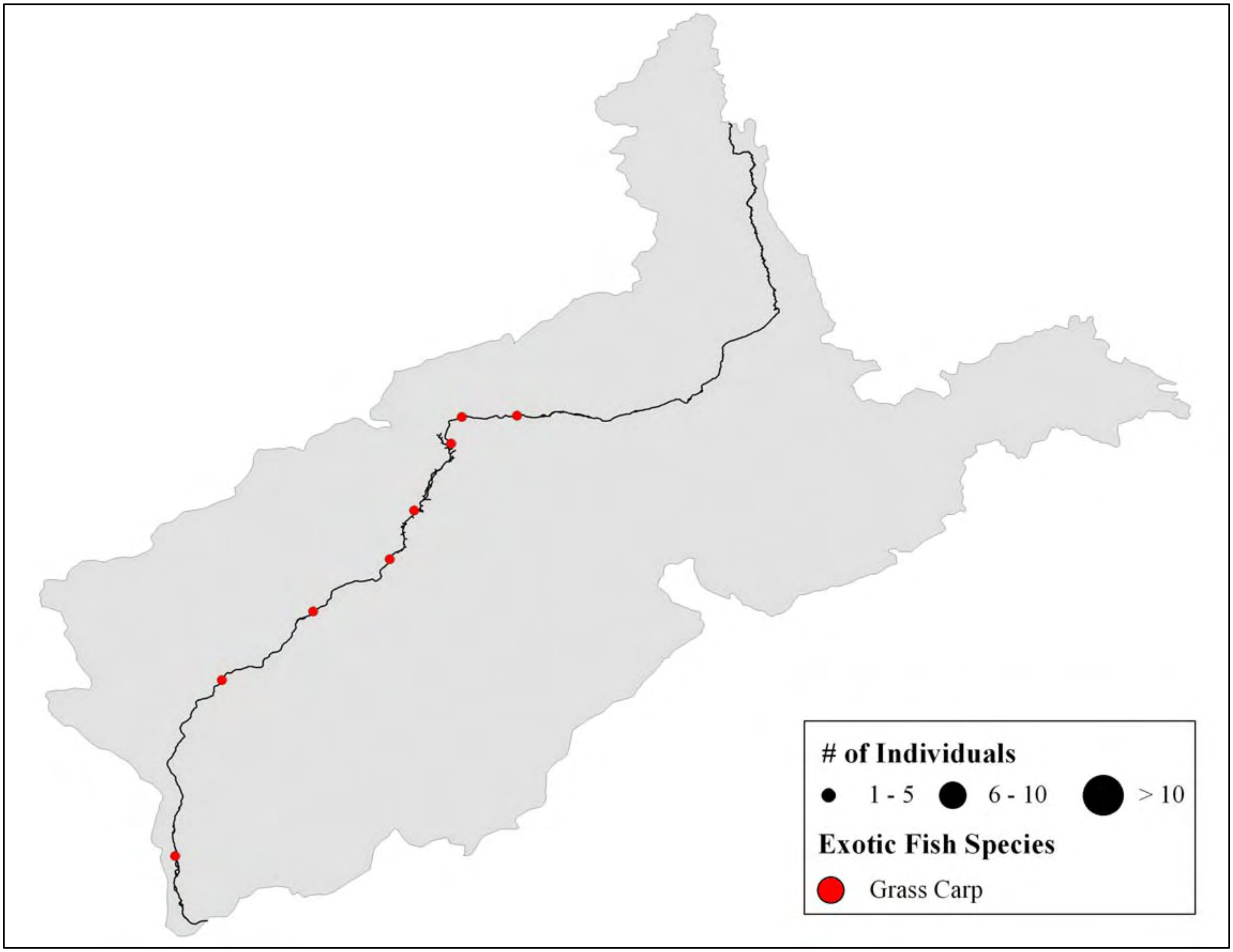

Figure 23. Location and density of Illinois River exotic fish species.

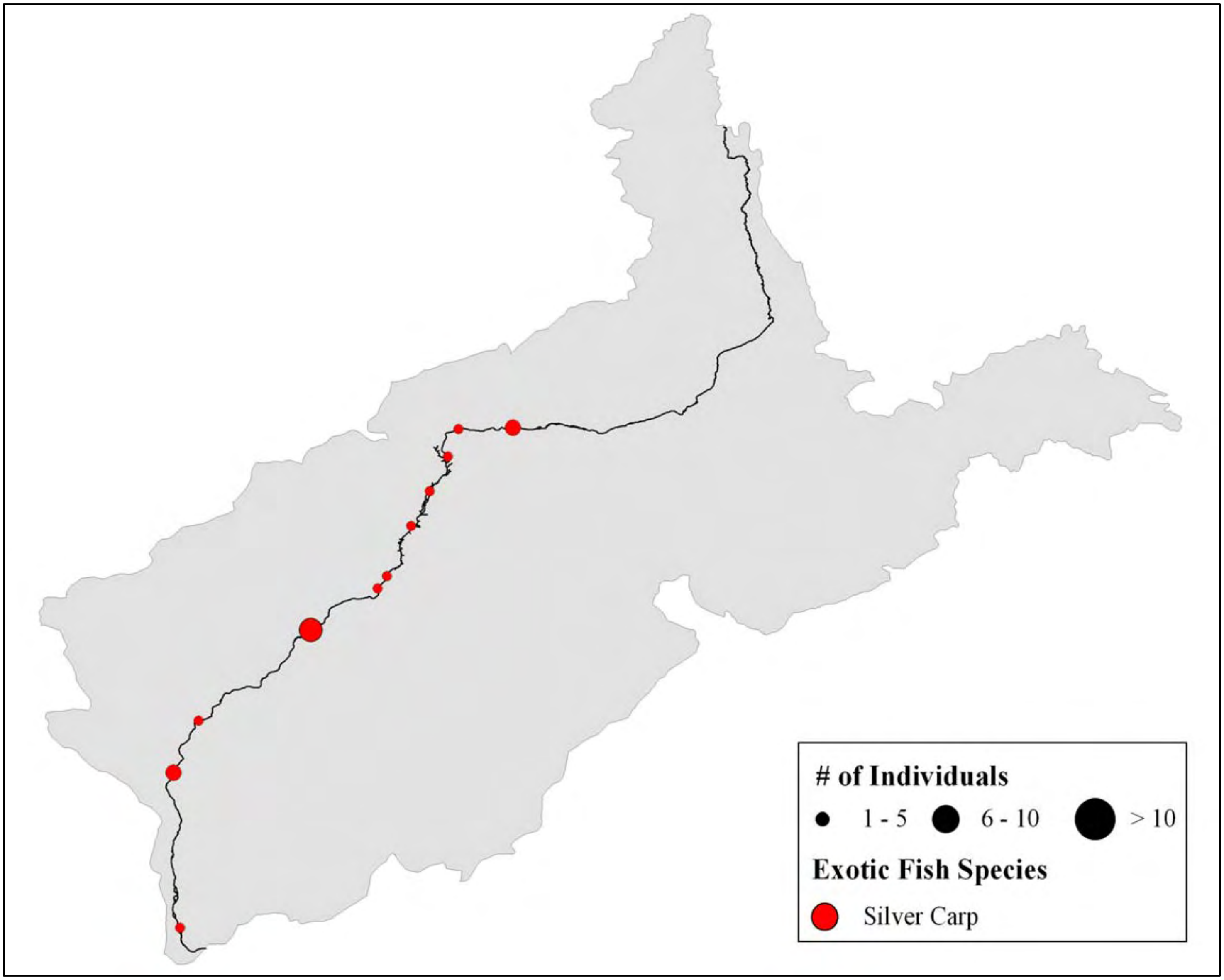

Figure 24. Location and density of Illinois River exotic fish species.

APPENDIX 5. RAW DATA

Due to the tremendous amount of raw data collected for this project, all data are compiled and available in digital format upon request. These data tables include raw electrofishing catch data, physical habitat data, QHEI metrics and nutrient data, where available, from up to 206 sites across seven basins.

5.1. ELECTROFISHING DATA

5.2. ORSANCO HABITAT DATA

5.3. QHEI METRICS